SELF-REGULATION FROM BIRTH TO AGE SEVEN: ASSOCIATIONS WITH MATERNAL MENTAL HEALTH, PARENTING, AND SOCIAL, EMOTIONAL AND BEHAVIOURAL OUTCOMES FOR CHILDREN

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ABSTRACT

This research is focussed on self-regulation across early childhood and its associations with later behavioural outcomes for children, maternal mental health and maternal parenting. Self-regulation refers to individuals' capacities to regulate their own behaviour, emotions and cognitions in a way that is adaptive to the circumstances in which they find themselves. Self-regulation develops rapidly in the early years and is a critical predictor of educational and life success. The research documented in this thesis contributes new and important Australian evidence through the use of a large longitudinal dataset and contemporary statistical modelling techniques.

This research involved a sample of 2880 children participating in the *Longitudinal Study of Australian Children* (LSAC) – B Cohort. Data from Wave 1 (birth to 1 year), Wave 2 (2-3 years), Wave 3 (4-5 years) and Wave 4 (6-7 years) were used. Self-regulation measures were maternal reports of children's sleep, emotional and cognitive regulation across the first three waves (birth to five years). The outcome measures were mother and teacher reports of social, emotional and behavioural problems at Wave 4 (6-7 years). Parenting variables investigated were maternal self-report of mental health, parenting self-efficacy and a number of parenting behaviours. Four studies were conducted to complete the program of research.

In Study 1, confirmatory factor analysis established measurement models for sleep, emotional and cognitive regulation across early childhood based on short parent-report measures. Longitudinal structural equation modelling then established that sleep regulation predicted subsequent emotion regulation and emotion regulation predicted subsequent cognitive regulation. The models in Study 2 found evidence for the predictive validity of early childhood self-regulation in relation to both mother- and teacher-reported behaviour problems at 6-7 years. Further models found evidence for mother- and child-driven effects in regards to maternal mental health and children's self-regulation. In the first three years poorer maternal mental health contributed to poorer self-regulation skills in children. From 2-3 years of age, child-driven effects emerged whereby children with poorer self-regulation skills contributed to poorer maternal mental health over time, over and above prior levels of psychological distress in mothers.

Study 3 again used structural equation modelling and found that while none of the parenting behaviours or mental health were moderators of the relationship between early self-regulation and later behaviour outcomes, several did mediate the relationship. Specifically, children with poorer self-regulation skills at 2-3 years contributed to poorer maternal mental health and self-efficacy and more negative parenting two years later, which in turn contributed to more behaviour problems for children at 6-7 years. Study 4 used latent profile analysis to describe the normative developmental path for self-regulation in Australian children. This normative path was experienced by 69 % of the sample and was characterised by consistently better emotional and cognitive regulation than the non-normative paths and sleep regulation that steadily improved from birth to 5. The remaining 31% of the sample were members of two poorer self-regulation profiles which displayed non-normative patterns of self-regulation development characterised primarily by decreasing sleep regulation skills across the first five years.

This program of research as a whole makes a significant contribution to the body of self-regulation research and to the early childhood education and care policy and practice environments in Australia. It is the first of its kind to use large sample longitudinal panel data to describe self-regulation development in Australian children, to provide a prevalence estimate for early childhood self-regulatory problems, and to establish empirical evidence for the bidirectional effects between maternal mental health and children's self-regulation across the early years. The findings have important implications for the support of children and parents during early childhood. They suggest that children at risk of longer term self-regulation problems and therefore early school behavioural problems might be identified by parent report of sleep problems and emotional and cognitive regulation. Families in which mothers have a significant history of depression and / or ongoing mental health challenges are an important risk group. An important next step for research and practice in this field is to identify the kinds of parenting supports and attributes of early childhood education and care that might best stimulate positive growth in children's self-regulation skills with the aim of giving all children the best chance of success across their schooling careers.

STATEMENT OF ORIGINAL AUTHORSHIP

The work contained in this thesis has not been previously submitted for a degree or diploma at any other higher education institution. To the best of my knowledge and belief, the thesis contains no material previously published or written by another person except where due reference is made.

The research was conducted with the support of an Australian Postgraduate Awards and QUT VC top-up scholarship. The research design was substantially my own work. I completed the data analyses. My supervisors provided advice and feedback.

This thesis uses unit record data from *Growing Up in Australia, the Longitudinal Study of Australian Children.* The study is conducted in partnership between the Department of Social Services (DSS), the Australian Institute of Family Studies (AIFS) and the Australian Bureau of Statistics (ABS). The findings and views reported in this paper are those of the authors and should not be attributed to DSS, AIFS or the ABS.

QUT Verified Signature

Signed: Date: 14/05/2014

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KEY ABBREVIATIONS USED ACROSS THE THESIS

BIC	Bayesian Information Criterion
BLRT	Bootstrapped likelihood ratio test
CAIC	Consistent Akaike’s Information Criterion
CBCL	Child Behaviour Checklist
CBQ	Child Behaviour Questionnaire
CFA	Confirmatory factor analysis
CFI	Comparative Fit Index
CTQ	Child Temperament Questionnaire
ECBQ	Early Childhood Behaviour Questionnaire
IBQ	Infant Behaviour Questionnaire
K6	Kessler 6 screener for symptoms of psychological distress
LMR	Lo-Mendell-Rubin test
LPA	Latent profile analysis
LSAC	Longitudinal Study of Australian Children
LSIC	Longitudinal Study of Indigenous Children
MMH	Maternal mental health
RITQ	Revised Infant Temperament Questionnaire
RMSEA	Root mean square error of approximation
SDQ	Strengths and Difficulties Questionnaire
SED	Socio-economic disadvantage
SEP	Socio-economic position
SEM	Structural equation modelling
STSI	Short Temperament Scale for Infants
STSC	Short Temperament Scale for Children
STST	Short Temperament Scale for Toddlers
TLI	Tucker Lewis Index
TTS	Toddler Temperament Scale
WLSMV	Weighted least squares mean variance estimator in Mplus statistical software
WRMR	Weighted root mean residual

CHAPTER 1: INTRODUCTION TO THE RESEARCH

1.1 Introduction

This thesis explores young children's self-regulation skills, associated behavioural outcomes for children, and transactional relationships with parenting in a group of Australian children participating in *Growing Up In Australia: The Longitudinal Study of Australian Childr*en (LSAC). The field of developmental research currently has a strong focus on self-regulation due to the growing evidence that these skills are critical for success and wellbeing across the lifespan. Self-regulation refers to individuals' capacities to regulate their own behaviour, emotions, and cognitions in ways that are beneficial to their functioning and adaptive to the circumstances in which they find themselves. Evidence is quickly building for the ways in which children's self-regulation skills develop over time, the developmental processes involved and the contributions made by aspects of parenting to these processes. While a great deal of knowledge has been produced, a number of factors indicate the need for continued research in this field to further enhance our understanding of this important feature of human development.

Given the key role of self-regulation in positive outcomes across the lifespan (Calkins & Williford, 2009), further research that can provide critical information to parents, early childhood professionals and the designers of early intervention and prevention programs and policy is warranted. Very few studies have focussed on the development of self-regulation as a broad concept, longitudinally over the course of the early years of life, a time when rapid and crucial growth is occurring. There is still more to learn on the transactional processes that exist between children's early regulatory skills, parenting behaviours and parent mental health over time. In particular, there have been limited studies examining the child-driven effects of poorer regulation skills on parenting longitudinally. Finally, the prevalence rates of early childhood self-regulation problems in Australian children are unknown. The degree to which poorer developmental profiles of self-regulation in early childhood confer risk in terms of social, emotional and behavioural outcomes in Australian children is not yet fully understood and requires further inquiry.

The current research builds knowledge about self-regulation, using a large sample of Australian children participating in the LSAC. The Birth Cohort of 5107 children has been followed from 2004 with data on child development and proximal environments collected biennially across four waves (Edwards, 2012). Findings are of interest to parents, early childhood practitioners, early interventionists and policy makers. The results contribute to a greater understanding of self-regulation development in Australian children than has previously existed. Importantly, the targets for additional support in relation to self-regulatory capacity and parenting factors are identified. The time points across early childhood at which these supports might have the greatest effect in reducing the risk of early school behavioural problems are also noted. This chapter provides the background to the current study and will present the research questions and related studies. This chapter also explains the significance of the study, defines the concept of self-regulation, and introduces the reader to the structure of the thesis.

1.2 Background to the Research

There is widespread understanding that the years from birth to age 5 constitute a critical period of development within the human lifespan (Shonkoff & Phillips, 2000) and that particular risk and protective factors play important roles in influencing development during this time. Developmental research is essentially grounded in the idea that if these factors can be accurately identified, then future policy drivers and intervention efforts can be targeted to support optimal development for all children through the bolstering of protective factors. Governments and others now fund such research and respond to findings with policy and practice, largely on the basis of economic evidence that investment in the early years pays exponential dividends long term in relation to the productivity and wellbeing of a society (Heckman, 2011).

A major focus of current early childhood policy is the degree to which children are ready to learn at the age of school entry (approximately 5 years). This is primarily because early school success has been shown to be predictive of ongoing academic achievement (Hoddinott, Lethbridge, & Phipps, 2002) and life success. Importantly, research has established that levels of social competence and problem behaviours in children tend to remain stable over the early school years (NICHD Early Child Care Research Network, 2003) suggesting that the developmental skills children bring with them to school are less amenable to change and intervention after children commence school, than they might be in the earlier years of life. It is therefore important to consider the ways in which these skills develop from birth, in order to improve children's educational outcomes across their schooling career.

Many Australian policies recognise the importance of the early years (generally considered birth to age 8 years), but only one specifically notes the ability to self-regulate as a key skill required for optimal functionality (the *Early Years Learning Framework*; Australian Government Department of Education Employment and Workplace Relations, 2009).This is surprising, given the substantive body of evidence pointing to self-regulation as a key factor in positive outcomes right across the lifespan. This suggests that self-regulation has not been highlighted enough as a key construct through the dissemination of pertinent research findings, and has therefore not sufficiently entered the lexicon of the Australian early childhood and policy making fields. Given the current and growing widespread emphasis on the early years it is timely that this is addressed, and that the critical role of self-regulation is investigated and promoted within a local context.

A substantial body of research primarily from North America and Europe has examined the relationships between self-regulation skills and social, emotional and behavioural outcomes for children. Typically these studies begin with infants at around 18 months of age, and while many are longitudinal, very few extend right across the period from birth to seven years. Early temperamental differences in attentional regulation have been found as early as 4 months of age (Sheese, Voelker, Posner, & Rothbart, 2009), with the ability to self-regulate increasing dramatically from the age of 12 months through to 7 years. Consistently, poorer self-regulation skills are associated longitudinally with problems relating to peers (Blandon, Calkins, & Keane, 2010; Olson, Lopez-Duran, Lunkenheimer, Chang, & Sameroff, 2011), poorer social skills (Sanson et al., 2009), and higher levels of externalising and internalising behaviour problems (Kim & Deater-Deckard, 2011; Morris, Silk, Steinberg, Terranova, & Kithakye, 2010). Further into adolescence and adulthood, self-regulation has been found to play a key role in motivation, aspiration, job and relationship satisfaction and mental health (McClelland, Ponitz, Messersmith, & Tominey, 2010).

Self-regulation is often studied from a relational developmental systems perspective and as such, the role of the proximal parenting environment in the early years is of continuing research interest and has been found to play a key role in the ways in which self-regulation skills develop in young children (Calkins, Graziano, Berdan, Keane, & Degnan, 2008). By and large, warm, responsive parenting has been linked with increasing self-regulatory capacity in children, while harsh parenting appears to be negatively associated with self-regulation (Olson et al., 2011). Although parent mental health has been well documented as an influencing factor in other areas of child development (Goodman et al., 2011), investigations into its relationship with children's self-regulation are less common and findings from these studies are inconsistent. While some studies find that maternal depression has a negative impact on children's self-regulation skills (Blandon, Calkins, Keane, & O'Brien, 2008), others do not (Jennings et al., 2008). Furthermore, most research in the field is conducted from the hypothesis that there are parent-driven effects only. However, there are some theoretical grounds upon which to explore child-driven effects. For example, children with poorer self-regulation skills may be more difficult to parent, therefore affecting parental mental health and perhaps parenting behaviours. While some researchers have found evidence of child-driven effects (Pesonen et al., 2008), this hypothesis is yet to be fully empirically investigated.

1.3 The Current Research

In this section the overall research problem addressed by the current project is discussed. The specific aim of the project and the associated research questions are then outlined. Finally, the methodology for the current research is previewed, including information on the dataset used and the approach to analysis

1.3.1 Research problem

This study investigates the patterns of self-regulation development from birth to age 5, and the ways in which maternal parenting and mental health interact with children's growing self-regulatory capacities to produce particular social, emotional and behavioural outcomes for children at age 6-7. While much is known about the protection and risk inferred by self-regulation profiles in regards to children's emotional, social and behavioural development, and the ways in which parenting is associated with such, there are still a number of gaps in the knowledge. The current program of research is designed to address many of these by way of conceptual, measurement, design and sample considerations. The scope of the research is limited by the selection of only maternal parenting and mental health. Future research should address the role of paternal behaviours and mental health in the development of self-regulation across early childhood.

There appears to be a growing movement towards the conceptualisation of self-regulation as a broad construct encompassing a range of hierarchical domains including behaviour, emotion and cognition (Blair, Calkins & Kopp, 2010; McClelland et al., 2010). However, there is limited empirical work that constructs and measures self-regulation in this broad way. Rather, most research focusses on one or two specific indices of self-regulation. Self-regulation develops rapidly in the early years and as such may need to be measured differently at various age points. Self-regulation may be particularly difficult to conceive of and measure in the first year of life. Despite infant sleep and excessive crying being used as indicators of regulatory problems in infancy (Schmid, Schreier, Meyer, & Wolke, 2010), and linked to similar sequelae as later measures of self-regulation, investigators have not examined the relationships among infant sleep and crying indicators and other measures of behavioural, emotional and cognitive regulation in examining self-regulation across the early years. How then do measures of self-regulation in the behavioural, emotional and cognitive domains behave at various time points from birth to 5 years and what picture do they present of an overall regulatory profile of children? Are biobehavioural indicators such as sleeping problems useful in understanding self-regulation as a whole across the early childhood period?

Very few studies in the current body of self-regulation research include data from the first year of life in a longitudinal design spanning birth to age seven. Given that the first five years of life are considered the critical developmental period for the growth of self-regulation skills, it is essential that typologies of self-regulation and influencing factors, such as parenting, are more thoroughly explored longitudinally across this time frame. With most research to date conducted in North America and Europe, it is also important to extend current knowledge relevant to the Australian context. What does the normative profile of self-regulation development look like for young Australian children? How do children's self-regulation skills interact with the parenting behaviours they are exposed to over time? In particular, how does a child's regulatory capacity and maternal mental health influence each other over time? How do particular aspects of self-regulation or early childhood self-regulation typologies relate to social, emotional and behavioural competencies during the early school years?

1.3.2 Research questions and studies

Four studies were designed to address the following four research questions in turn.

1. What are the relationships among parent-reported sleeping problems, temperamental reactivity and temperamental persistence over the first five years and what do they tell us about early childhood self-regulation?

2. How is self-regulation from birth to age 5 associated with maternal mental health across time and children's social, emotional and behavioural outcomes at age 6-7?

3. Is the relationship between children's self-regulation during the third year and child behavioural outcomes in the seventh year moderated or mediated by maternal parenting and mental health measured in the fifth year?

4. What are the longitudinal profiles of self-regulation in children aged birth to 5 and how are they related to child outcomes and parenting?

1.3.3 Methodology

The Longitudinal Study of Australian Children (LSAC)

The current study is a secondary data analysis of the *Longitudinal Study of Australian Children* (LSAC). The LSAC is the first longitudinal study of its kind to be under taken in Australia. The study is funded by the Australian Government Department of Social Services (DSS; formerly known as the Department of Families, Housing, Communities and Indigenous Affairs) and managed by the Australian Institute of Family Studies (AIFS), in partnership with the Australian Bureau of Statistics (ABS; Edwards, 2012). Data collection began in 2004 with two cohorts of children participating. The B (Birth) Cohort had 5107 children aged from birth to 12 months of age and the K (Kindergarten Cohort) consisted of 4983 children aged 4–5 years. Data has been collected biennially from both cohorts from 2004 with Wave 4 data (collected in 2010) the most recently released dataset for use by researchers. Wave 5 of data collection was conducted in 2012 when the B Cohort were 8–9 years and the K Cohort were 12–13 years old. It is expected that the Wave 5 dataset will be released for use in December 2013.

The LSAC study was designed by a multidisciplinary team of leading researchers in collaboration with key stakeholders and policy bodies. The broad-based survey methodology focuses on the Study Child, their development across a range of domains and the context surrounding the child, including parenting, community, child-care and education environments. Direct measures of children's physical health and cognitive abilities are used. The primary data collection tools are survey instruments completed by parents, carers and teachers, as well as by the study child once they are old enough to do so. Parents also complete time use diaries for children. The overarching research questions guiding the LSAC study are: What are the childhood experiences and conditions that impact on child, adolescent and adult outcomes and on trajectories of development? What are the mechanisms underlying linkages and interactions and how do these change over time? What factors and processes protect children from events or contexts that increase the risk of poor outcomes? (Australian Government Department of Families, Communities, Housing and Indigenous Affairs, 2009).

LSAC data are available for use by researchers upon application. The current study uses data collected from the B Cohort across the first four waves to address the research questions. Analyses use the first release of the Wave 4 dataset distributed in 2011.This dataset includes the data for Waves 1 to 4. The inclusion of four waves of data enables the construct of self-regulation to be examined over the crucial developmental period of birth to age 5, with its relationship to outcomes as measured at 6-7 years examined. A range of measurement instruments that conceptually, theoretically and empirically relate to self-regulation were identified and used. Further, associations between self-regulation, parenting aspects and outcomes for children were examined. Additional details on LSAC, its design, sampling and measures are provided in Section 3.3.

Approach to analyses

Structural equation modelling (SEM) was selected as the foundation analytic methodology for this thesis. SEM has been described as a combination of confirmatory factor analysis (CFA) and multiple regression, as it examines the relationships between latent variables by extending on measurement models (essentially the CFAs) into structural models (Schreiber, Nora, Stage, Barlow, & King, 2006). SEM has grown substantially in popularity in recent years (Jackson, Gillaspy, & Purc-Stephenson, 2009) and is used widely in developmental psychology and educational research.

Each of the studies begins with an examination of the descriptive statistics and bivariate correlations of the variables of interest. Study 1 uses CFA to test measurement models for sleep, emotional and cognitive self-regulation at three time points from birth to age 5. The longitudinal and reciprocal relationships among these self-regulation indices are then examined using SEM. Study 2 uses longitudinal panel SEMs to simultaneously estimate measurement models for self-regulation along with the longitudinal and reciprocal relationships among these and behavioural outcomes for children and maternal mental health. Study 3 further builds on the previous studies by using path analysis within SEM to examine the extent to which maternal mental health and parenting (warmth, hostility, anger, reasoning, consistency and self-efficacy) act as mediators and moderators of the relationship between early self-regulation and later outcomes for children.

Study 4 takes a person-centred approach by using latent profile analysis (LPA) to establish longitudinal profiles of self-regulation development across the first five years of life. LPA is a semi-parametric group based approach that allows for the estimation of qualitatively different groups when group membership cannot be observed *a priori*, and has been used recently by a number of researchers within developmental psychology (Degnan, Calkins, Keane, & Hill-Soderlund, 2008; Hill, Degnan, Calkins, & Keane, 2006). This approach allows for the identification of a normative developmental pathway for self-regulation across early childhood, even when the indicators of such necessarily change over time. Profile membership is then used as a variable in path analyses examining the extent to which profile membership predicts later outcomes for children and is related to maternal parenting and mental health.

1.4 Significance of the Research

This research is significant in its potential to inform practice and policy in the early childhood field, and to support the development of interventions addressing self-regulation development, with implications for wellbeing across the lifespan. Recent data indicate that 24% of Australian children enter school developmentally vulnerable on one or more domains (Centre for Community Child Health and Telethon Institute for Child Health Research, 2009). Furthermore, one in five Australian adults (approximately 3.2 million people), experience a common mental illness such as an anxiety or mood disorder in any 12 month period (Australian Bureau of Statistics, 2008). It is clear then that there is significant room for improvement in supporting the health and wellbeing of Australians, and this program of research is based on the premise that targeting early self-regulation skills may be key to driving more positive outcomes for individuals across the lifespan.

Typically, early intervention efforts in Australia focus on families considered socially at risk or disadvantaged, with risk indicators such as being of minority status, lower socio-economic status or single parenthood used to identify these families (Australian Government Department of Families Housing Community Services and Indigenous Affairs, 2012). While these elements remain of great importance, there is growing evidence to suggest that as well as social risk, practitioners should consider biological or child temperamental characteristics, and early indicators of regulatory problems as indicative of an 'at risk' target group. Reasons for this include that early sleeping, feeding and crying problems have been linked with later social problems (Schmid et al., 2010) and that degree of regulatory capacity across early childhood has been established as both a protective factor (Ramani, Brownell, & Crockett, 2010) and a risk factor (Kim & Deater-Deckard, 2011; Morris et al., 2010; Olson et al., 2011) in terms of social, emotional and behavioural outcomes for children. If children's early regulatory capacity is to be considered as a risk factor worthy of identification and intervention, practical and easily obtained indicators are required for use by parents and practitioners in the field.

The current research addresses this need by taking a theoretically driven approach to establishing measurement models for self-regulation at three time points from birth to age 5. Brief parent-report measures that could be used efficiently and reliably in the field are used as the prime indicators. The measurement models developed provide the basis for the identification of a group of ‘red flags’ that may be used by practitioners to identify children and families at the greatest risk of poor self-regulation, and in turn, poorer outcomes. This group can then be targeted by early intervention and prevention efforts.

Interventions reported to date rarely focus on children’s self-regulation skills as the main target for change. One recently reported intervention that did focus specifically on behavioural self-regulation in five-year-old children found evidence suggesting that the intervention was effective in promoting more positive behavioural and early academic outcomes for those children who began the program with lower regulatory capacity (Tominey & McClelland, 2011). While this is promising, there are no equivalent studies found addressing self-regulation in children aged under 5 years, or the role that parenting programs might play in supporting parents of children with regulatory problems. Given that positive parenting is likely to be the most critical mediator for children with early regulatory problems (Blandon, Calkins & Keane, 2010), further careful examination of the way in which parenting interacts with self-regulation in the early years will provide valuable insight to the developers of early childhood and parenting interventions. The findings of the current study may stimulate more consideration of self-regulation as a target and primary focus of future early intervention and parenting support efforts.

While there is an existing body of research documenting the relationships between parenting behaviours and children’s self-regulation, there are a limited number of studies exploring associations with parent mental health and even fewer which examine the reciprocal and longitudinal relationships between these components. Further research on these relationships is clearly warranted, especially during the early childhood period when regulatory skills may be most susceptible to change through parenting. Theoretically, parents of children with poorer self-regulation skills may be at risk of poorer mental health and in need of extra support due to the sometimes challenging nature of these children’s behaviour. However, there is limited evidence to support this hypothesis to date. Parental mental health is a vital aspect to consider not only because of the detrimental health effects for the parent but because of the potential for poor parental mental health to compromise positive parenting and child development (Goodman et al., 2011). The current research investigates the parent-to-child, and child-to-parent effects of children's self-regulation skills, maternal parenting behaviours and maternal mental health over the first five years of life within a transactional model of child development. Theoretical concerns over the mental health of mothers of children with poor self-regulation skills are tested and the results provide insight into whether or not these mothers should be considered particularly at risk and further supported. Results also identify the types of parenting behaviour that are most conducive to optimal self-regulation development. The findings can be used to inform the timing and content of future parenting support programs that aim to influence children's self-regulation skills and parenting behaviours.

1.5 The Nature of Self-Regulation

Traditionally, self-regulation research has stemmed from the study of temperament. It has been considered as a component of temperament (Sanson et al., 2009); as a significant organiser of temperament (Rothbart, Ellis, & Posner, 2011); and as a mediator between temperament and later personality or outcomes (Hoyle, 2010). Self-regulation is increasingly recognised and investigated by researchers from beyond the temperament field including those from the developmental neuroscience, developmental psychopathology, and education fields.

While there remains much debate about self-regulation, how to define it and how to measure it (Vohs & Baumeister, 2011) there is a general consensus that self-regulation is a multidimensional construct that broadly includes the regulation of behaviour, emotion, and cognition (McClelland et al., 2010). Within each of these sub-domains of self-regulation, a variety of constructs are researched, and a number of different terms used. Researchers approach the deconstruction and measurement of the latent, multidimensional construct of self-regulation in various ways depending on their theoretical and conceptual frameworks, and study goals. The ways in which researchers choose what to measure, and explore the relationships between the components of self-regulation are also influenced by the developmental period under examination, as regulatory capacities change over the course of the early years. In the current study, self-regulation refers to the behavioural, emotional and cognitive processes that serve to modulate an individual's reactivity in an effort to achieve equilibrium and more adaptive responses and outcomes.

1.6 Overview of the thesis

This thesis consists of eight chapters. This chapter has provided the introduction to the thesis including the research questions, the nature of the dataset used, the analysis methodology selected and the significance of the research. Chapter 2 details the results of a systematic literature review. This review was conducted in order to ensure that existing research findings and methodologies that were highly relevant to the current study were captured and synthesised. This also allowed the author to best determine the gaps in the current knowledge base and to situate the current study accordingly.

Chapter 3 provides thorough details on the methodology for this program of research. It discusses the LSAC dataset and issues associated with secondary data analysis. It details the sample selection procedure used and describes the research participants. In this chapter the variables selected to measure self-regulation, maternal parenting and mental health and children's behavioural outcomes are described. More detailed information on the analytic techniques used throughout the study is then provided and approaches to missing data are discussed. Finally, the four studies that comprise this research program are briefly previewed.

Chapters 4, 5, 6 and 7 present the results of the analyses conducted to address each of the four research questions in turn. In each results chapter the research question and background are introduced, followed by a brief explanation of the analysis methodology. Descriptive statistics and results of the SEMs and path analyses are then provided. Each results chapter concludes with a brief discussion of the findings.

Chapter 8 is the final chapter and presents an in-depth synthesis and discussion of the research findings. It concludes with presenting the limitations of the study and recommendations for future research. It also sets out the implications of the findings for policy and practice. References and the appendices are found in the final section of the thesis.

1.7 Conclusion

There is a strong focus in current international research on the importance of the early years of a child's life in influencing wellbeing and productivity across the lifespan. National policies and funding programs aim to provide early support to children and parents to ensure that children have the best chance of a positive developmental trajectory. These family support programs often target socially at risk populations. The current research proposes that in addition to social risk, regulatory capacity in children should be recognised as a potential risk factor that may warrant further support for particular families.

Research to date somewhat supports this view on the importance of self-regulation skills and their association with positive life outcomes for individuals. However, there is still more to be learned about the ways in which the broad concept of self-regulation can be best conceptualised and measured at various time points during early childhood, and how the normative developmental pathway of self-regulation in Australian children can be described. Further detailed information on the longitudinal and reciprocal relationships between children's self-regulation skills, parenting behaviours and parent mental health is also warranted in order to best inform future intervention designs and support for families. Findings from the current program of research will contribute to a more widespread recognition and understanding of self-regulation and its development in the early years. The results will be of interest to policy makers, parents, early childhood practitioners and early intervention designers.

This chapter provided the background to the current study, introduced the proposed research questions, and explained the significance of the study. Chapter 2 is based on a systematic literature review of research in the field. It provides a discussion on the historical and definitional aspects of self-regulation, discusses its theoretical structure, the ways in which it is measured and what is known on the development of self-regulation in the early years of life. The chapter also synthesises the research conducted to date in relation to self-regulation and its associations with outcomes for children and early parenting before discussing the implications of the extant body of research to the present study. Finally, Chapter 2 presents the conceptual model developed to guide this program of research.

CHAPTER 2: RESEARCH AND THEORY ON SELF-REGULATION

2.1 Introduction

Learning to internally regulate one's behavioural, emotional, and cognitive reactions toward more adaptive outcomes is a key task during early childhood. It is likely that an individual's propensity to develop regulatory skills is influenced by both individual temperamental characteristics and the proximal early parenting environment in which individuals are raised (McClelland et al., 2010). Better self-regulation skills have been associated with a range of more positive outcomes across the lifespan and as such are an important focus of current research. It is vital to gain knowledge on the types of parenting environments which best support or detract from children's regulatory growth. The literature review presented in this chapter aims to address two questions. How is self-regulation conceptualised and measured from birth to age 5? How are children's self-regulation skills longitudinally and reciprocally related to parenting behaviour and mental health, and children's social, emotional and behavioural outcomes?

A systematic literature review was undertaken to inform the development of this chapter (see Appendix A for protocol). This systematic review was designed to ensure that research findings and methodologies that are highly relevant to the current study were captured and synthesised. This also allowed the author to best determine the gaps in the current knowledge base and to situate the current study accordingly. To be selected for inclusion, studies were required to include at least one measure of child self-regulation, along with either one measure of a parenting construct, *or* a measure of social, emotional or behavioural outcomes for children. Included studies also had to be longitudinal in nature with at least one point of data collection occurring under the age of seven years. As the current research will use data from a population-representative sample of children, studies that focussed on special population groups were not included in the review (such as highly disadvantaged families, premature children, specific cultural groups, children with disabilities or children exposed to trauma). The only special population studies included were those in which study participants were selected to be over-representative of poor results in the outcome areas of interest (social, emotional and behavioural competencies). These studies were included due to their potential relevance to the current research which has a focus on social, emotional and behavioural outcomes in relation to early self-regulation.

The search protocol detailed in Appendix A was undertaken in two stages. The first search stage was undertaken in August 2011 (searching for items published from January 2006 to July 2011), and the second stage in July 2013 (searching for items published from August 2011 to July 2013). Upon careful review, 29 of these items were found to meet the inclusion criteria in the first search stage which spanned five and a half years of work. An additional 21 papers from the second search stage which spanned just less than two years of work met inclusion criteria. This relative increase in the amount of publishing in the area of self-regulation highlights the growing interest and research output in this field of work. Appendix B details the papers and provides summary information on the study sample, measures used and key findings. These publications are also discussed throughout this chapter, with additional literature sourced to further illuminate key topics. Particular reference was given to key authors in the field who were consistently cited throughout the review papers and relevant studies from prior to the search period.

This chapter begins with a brief discussion on the historical and definitional issues related to self-regulation, before discussing its theoretical structure, the ways in which it is measured and what is known on the development of self-regulation in the early years of life. The chapter then goes on to discuss the research conducted to date in relation to self-regulation and its associations with outcomes for children and early parenting. The final section of the chapter will discuss the implications of the extant body of research to the present study and will present a conceptual model developed to guide the program of research.

2.2 Historical and Definitional Issues on Self-Regulation

The study of self-regulation stems primarily from an extensive history of research examining individual temperament and its associated correlates. Early temperament research pioneers Thomas and Chess defined temperament primarily from a behavioural point of view (Goldsmith et al., 1987) with their dimensions of temperament including approach-withdrawal, adaptability, quality of mood, intensity of reaction, distractibility, persistence or attention span, rhythmicity, threshold of responsiveness and activity level (Thomas & Chess, 1977). While these nine dimensions have undergone considerable refinement in years since, it is clear from the outset that items such as distractibility, persistence and attention span were some of the precursors to current definitions of self-regulation, in particular cognitive or attentional regulation.

The most common definition of temperament used currently refers to the constitutionally based individual differences in reactivity and *self-regulation* that are evident from early childhood (Rothbart, 2004), further highlighting the key role of self-regulation within the temperament paradigm. *Reactivity* refers to "responses to change in the external and internal environment, measured in terms of the latency, duration and intensity of emotional, orienting and motor reactions" (Rothbart, Sheese, Rueda, & Posner, 2011, p.207), and is considered to be largely biologically driven and hence not amenable to change. *Regulation* refers to the processes that serve to modulate this reactivity. Compared to reactivity, it is thought to involve more learned behaviours and be driven by experience and, as such, is considered more amenable to change primarily through early experiences with caregivers. It is perhaps because of this notion that self-regulation is the more changeable part of temperament, influenced across time by experience and maturation that it has received so much more recent attention in the research literature.

Further reinforcing the role of self-regulation as a key temperament construct, it has been named as one of three broad dimensions of temperament that are currently generally agreed upon (while the components and finer grained aspects of each remain the subject of debate). These are: reactivity (negative or positive emotionality), sociability (or inhibition, approach-withdrawal) and *self-regulation* (Sanson et al., 2009). As a key aspect of temperament then, self-regulation has received much attention by researchers from this paradigm and has been generally defined by temperament researchers as referring to the neural and behavioural processes by which individuals modulate their emotions and behaviour (their reactivity; Rueda, Checa, & Rothbart, 2010). Temperament researchers tend to consider self-regulation to be highly important in mediating between biological constitution (temperament as a whole) and positive outcomes in general (Sanson et al., 2009) and have commented that self-regulation is a "major contributor to the organisation of temperament" (Rothbart, Ellis, et al., 2011, p.441).

A recent emergence of published handbooks on self-regulation (Berger, 2011; Forgas, Baumeister, & Tice, 2009; Hoyle, 2010; Sokol, Muller, Carpendale, Young & Iarocci, 2010; Vohs & Baumeister, 2011), indicates the growing recognition of its importance in the understanding of development across the lifespan and also document the range of research paradigms from which self-regulation research is being produced. Developmental neuroscientists tend to be interested in the brain structures and neural mechanisms involved with regulatory tasks and the ways in which regulatory mechanisms stimulate and interact with other areas of brain development (Hrabok & Kerns, 2010). Developmental psychopathology researchers focus on the ways in which abilities and deficits in self-regulation may account for the development of various psychopathologies and have noted that difficulties in self-regulating are implicated in many, if not all, of the challenges people face across the lifespan including addiction, depression and underachievement (Vohs & Baumeister, 2011). Personality researchers, similarly to those from the temperament field posit that self-regulation is the key mechanism by which early temperament is shaped into adult personality (Hoyle, 2010), and reinforce that while self-regulation does have a constitutional basis, it is developed dynamically in relation to experience. Educational researchers are typically concerned with the ways in which regulatory capacity promotes school success and the ways in which teachers and school settings support self-regulation, with self-regulation found to be key in the consideration of children's school readiness and academic achievement (Blair et al., 2010; Calkins & Williford, 2009).

There appears to be recent agreement that self-regulation may be best viewed from a *relational developmental systems perspective* and similar system theories (Blair et al., 2010; McClelland et al., 2010). These perspectives emphasise that development occurs as a result of the bidirectional and integrated relations within multiple environments that individuals experience (Lerner, 2006). It recognises that multiple dynamic interactions result in individual development, from the genetic and other proximal levels to distal levels such as the social and political climate (Gottlieb, Wahlsten, & Lickliter, 2006; Lerner, 2006). In a further reflection of the systems approach to understanding self-regulation, leading researchers Blair and colleagues

(2010, p.65) define regulation as “a process through which one system or domain of psychological functioning modulates the level of another in order to maintain an adaptive balance or equilibrium in response to internal or external stimulation”. This suggests that self-regulation is itself the artefact of intra-individual systems influencing other systems, while also being developed through the interaction of the individual with extra-individual systems such as the family environment and learning experiences. These perspectives share similar views to the *bio ecological* model developed by Bronfenbrenner and widely cited in developmental research (Bronfenbrenner & Morris, 2006). They also reflect recent *transactional* models of child development (Sameroff, 2009). Studies with a transactional framework aim to empirically test both child- and parent-driven effects by using statistical modelling that is able to account for longitudinal and bidirectional relationships among variables (Choe, 2012; Shaw, Gross, & Moilanen, 2009).

These theories reject any arbitrary divide between nature and nurture and instead favour the position that both nature and nurture contribute to an individual’s stable and changing characteristics. Much of the current body of self-regulation research reflects this perspective by investigating the various associations between self-regulation and physiological processes within individuals, along with other relevant proximal processes such as parenting and more distal influences such as maternal education and family income. In particular, evidence that supports the notion that self-regulation develops from interactions between an individual’s temperamental characteristics and the parenting environment highlights the relevance of these perspectives to the field of self-regulation (Belsky, Pasco Fearon, & Bell, 2007; Bridgett et al., 2011; Eisenberg et al., 2010; Graziano, Keane, & Calkins, 2010; Lengua & Kovacs, 2005; Lengua, Wolchik, Sandler, & West, 2000).

2.3 The Structure of Self-Regulation

Figure 2.1 depicts and organises the concepts and terminology used in the papers reviewed within the systematic literature review, with these further discussed below.

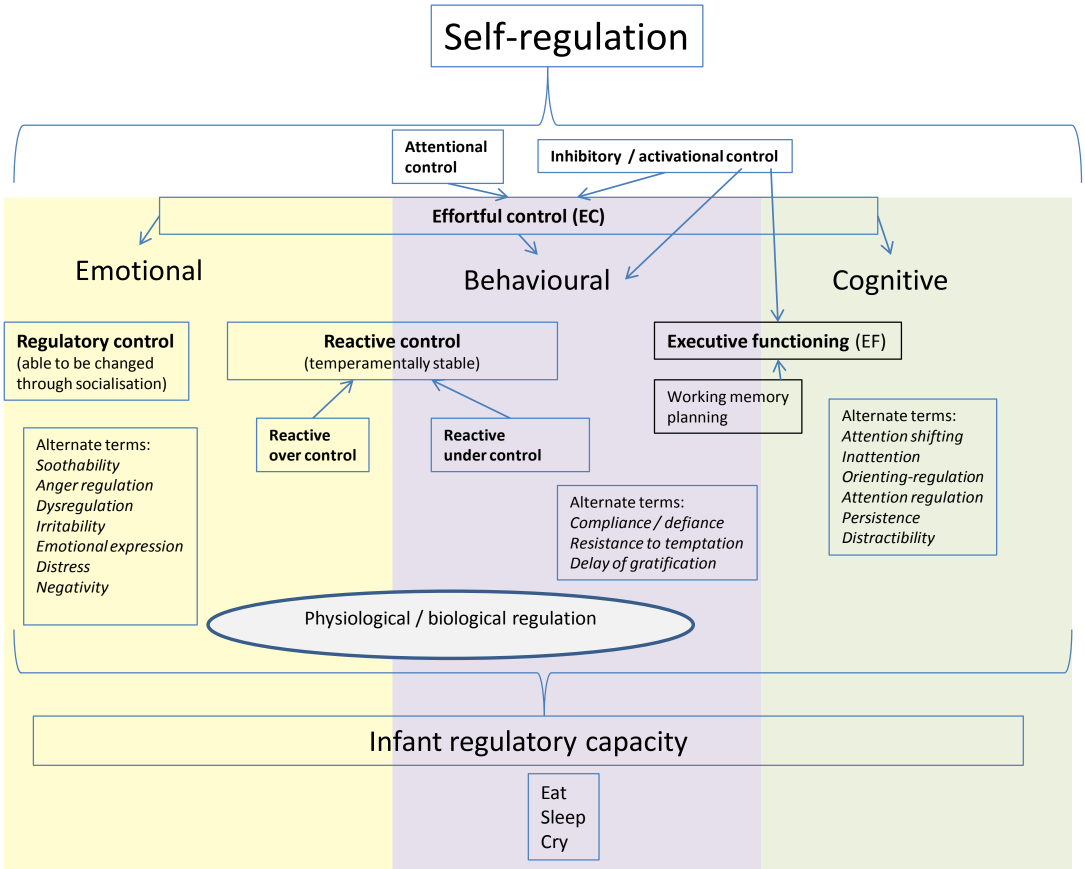

Figure 2.1. The structure of self-regulation.

A key construct in the self-regulation and temperament literature is *effortful control*, defined as "the ability to voluntarily regulate behaviour and attention, as seen in the inhibition of a dominant response and activation of a subdominant response" (Rothbart, Sheese, et al., 2011, p. 207). Key proponents and researchers of effortful control include Rothbart (Rothbart, Ellis, et al., 2011), and Eisenberg (Eisenberg, Smith, & Spinrad, 2011) who have identified effortful control as playing an important role in moderating the associations between early temperament and social and emotional adjustment. While most of the studies by these authors refer to effortful control as the regulation of behaviour and attention (which could be considered in the cognitive domain of regulation), Spinrad and colleagues (2006) use effortful control as an indicator of emotion regulation. It can then be considered that effortful control spans all three domains of regulation, hence its role as a key concept in the field. In fact some leading researchers have recently used the specific term effortful control and the broader term of self-regulation as synonymous (Eisenberg et al., 2011).

Effortful control is conceptualised as being made up of both attentional control and activational / inhibitory control. *Attentional control* refers to the ability to voluntarily focus or shift attention as needed, for example to maintain focus on a task even when distractions are present, or to ignore dominant cues when asked to pay attention and respond to subdominant cues provided. *Inhibitory control* refers to the ability to effortfully inhibit behaviour as required, for example, to wait for a cue before touching a tempting snack. Researchers sometimes also include *activation control* as a measure of effortful control. This refers to the ability to activate behaviour when needed, for example, to complete a task that one doesn't feel like doing (Eisenberg et al., 2011).

A related regulatory concept is *executive function*, which is considered to comprise of *inhibitory control* (also a part of effortful control and defined above), along with the other cognitive functions of *working memory*, *planning*, and *set shifting* (Bernier, Carlson, & Whipple, 2010). Unlike effortful control, executive functions have largely been researched from within the neurodevelopmental / cognitive science paradigms, and only within the last eight years has executive function research been well integrated within the broader self-regulation research paradigm (Rueda, Posner, & Rothbart, 2005). Working memory refers to the active maintenance of information in short-term storage for the purpose of executing a specific task. Set shifting or mental flexibility refers to the switching of attention or cognitive set between distinct but often closely related aspects of a given object or task (Blair et al., 2010).

While effortful control is considered to comprise the voluntary processes of regulation, researchers have also identified regulatory processes that appear to be more involuntary. *Reactive control* is one of these and is considered to be made up of reactive overcontrol and reactive undercontrol. Children exhibiting *reactive overcontrol* may be highly inhibited and approach novel situations with fear and withdrawal. Children exhibiting *reactive undercontrol* may be highly impulsive and seemingly unable to control their level of motor activity and attention, as typically seen in children with Attention Deficit Hyperactivity Disorder (ADHD; Eisenberg et al., 2004).

A recent review of research on effortful control and executive function explicates the significant overlap in these constructs (Zhou, Chen, & Main, 2012) and confirms the somewhat confused picture of self-regulation depicted in Figure 2.1. These authors posit that the primary differences between effortful control and executive function stem more from differences between the research “traditions” that typically investigate these concepts, rather than from actual differences in the developmental constructs themselves. They call for a more integrated model of self-regulation which would reduce overlap and confusion in these concepts. The current research somewhat addresses this by testing an integrated measurement model for self-regulation which encompasses broad measures of behavioural, emotional and cognitive self-regulation, rather than focussing on highly specific self-regulatory components such as executive function or effortful control.

Emotional regulation as a construct has been the most debated of the three regulation domains and also one of the most researched in recent years. Cole, Martin and Dennis (2004) provided a pivotal summary of the definitional and methodological challenges in this field, commenting that while most studies fail to provide an operational definition of emotional regulation, and indeed there is no consensus to be found within the literature, the study of such is still highly valuable to our understanding of human development. More recent reviews of the field have described emotional regulation research as “maturing” (Tamir, 2011), but have also highlighted the continued diversity in how the construct is understood and measured (Adrian, Zeman, & Veits, 2011). Emotional regulation is considered to comprise the interplay between an individual’s natural reactivity to emotion-inducing events, as well as their capacity to control these reactions (regulatory control; Blair et al., 2010). The term has been used to variously refer to the ways in which emotion regulates other systems within individuals (e.g., attentional systems), and the ways and degrees to which individuals employ regulatory strategies when experiencing emotion.

One of the most unclear terms used in the self-regulation body of research is *physiological regulation.* Some researchers use the term to refer to the nervous system processes and indicators of such (primarily vagal suppression and heart rate) that have been found to be associated with emotional regulation (e.g., Blandon et al., 2008; Degnan et al., 2008). Calkins also at times uses the term *biological regulation* to refer to these same concepts (Calkins & Williford, 2009). For the purposes of the current research vagal suppression and other biophysiological measures are conceptualised as physiological *indicators* of self-regulation (usually emotional regulation).

In contrast, other researchers have used the terms *physiological regulation* and *biobehavioural organisation* to refer to the ways in which infants regulate their sleep patterns (Bernier, Carlson, Bordeleau, & Carrier, 2010). Sleep problems, along with excessive crying and feeding problems, have also been used as indicators of *regulatory problems* or *regulatory disorders* in early childhood (Schmid et al., 2010) and are considered as diagnostic criteria of regulatory disorders for children aged birth to 3 years within clinical classification and treatment systems (Emde et al., 2005). Degangi, Breinbauer, Doussard Roosevelt, Porges, and Greenspan (2000) construct regulatory disorders as potentially comprising both eating and sleeping issues, but also excessive irritability and sensory processing challenges. Uses of the term *regulation* in this way lead to the question as to whether or not biobehavioural measures such as sleep problems are useful indicators of early self-regulation capacity, particularly during infancy where measurement of the three domains of self-regulation can be problematic.

While some recent research has used sleep problems as indicators of infant regulatory capacity (Choe, 2012), none have combined these with measures of temperamental measures of infant emotional regulation. Further, the extent to which problems with sleep regulation continue to be a useful indicator of overall self-regulation in children beyond the infancy period has not been investigated. This program of research will address these gaps by including measures of sleep regulation across time in investigating pathways of self-regulation development in young children. The following section provides a brief summary of the pertinent research to date in relation to early sleep regulation and its relationship to other aspects of self-regulation and associated outcomes for children.

2.3.1 Self-regulation and sleep

Only 4 of the 50 studies that met the search criteria for this systematic literature review included sleep as an indicator of regulatory abilities in infants and young children (Choe, 2012; Schmid et al., 2010; Troxel, Trentacosta, Forbes, & Campbell, 2013; Zentall, Braungart-Rieker, Ekas, & Lickenbrock, 2012). Each of these studies used parent-reported sleep problems, but used slightly different measures and also positioned sleep differently in relation to self-regulation as a whole. Troxel and colleagues (2013) and Zentall and colleagues (2012) examined sleep problems in relation to attachment security during infancy and early childhood but did not combine sleep regulation with other measures of self-regulation. Troxel and colleagues (2013) did examine negative emotionality, a concept linked with emotional regulation, as a moderator in their study, but found no correlation between negative emotionality and sleep problems. Rather, for infants high in negative emotionality, sleep problems were more likely to mediate the relationship between attachment security at 2 years and behaviour problems at 5 years.

Choe (2012) and Schmid and colleagues (2010) both used parent-reported sleep problems in combination with crying and feeding problems to identify infants as having regulatory problems. Choe (2012) used a single item asking whether or not the infant slept too little, too much or about the right amount. He found regulation status to moderate the bidirectional relationships between maternal depression and child behaviour problems across the first three years, with child-driven effects found only for well-regulated infants. Schmid and colleagues (2010) extended the use of sleep, crying and feeding indicators to tap self-regulation to include the period up to 5 years of age. They found that such regulatory problems were predictive of adaptive and behaviour problems at 5 years, however did not examine these indicators in relation to other measures of self-regulation from the cognitive or emotional domains. It is interesting to note that the four studies that conceptualised sleep as part of self-regulation in children were all conducted in very recent years, perhaps indicating a growing interest in the role of sleep in children's development of their regulatory capacity.

Further information about the potential role of sleep as an indicator of self-regulation is found by turning to population health research where studies of sleep problems in children are much more common (Hiscock, Canterford, Ukoumunne, & Wake, 2007; Martin, Hiscock, Hardy, Davey, & Wake, 2007; Quach, Hiscock, Canterford, & Wake, 2009). Some studies from the temperament and parenting literature also provide insight into the role of sleep in child development. These studies have found sleep problems to be linked with similar sequelae as other measures of self-regulation, including behaviour problems (Hemmi, Wolke, & Schneider, 2011, Hiscock et al., 2007; Schmid et al., 2010; Troxel et al., 2013), higher diagnosis rates of ADHD

(Hiscock et al., 2007), lower social skills (Schmid et al., 2010), poorer academic achievement (Bruni et al., 2006) and poorer executive functioning (Bernier, Beauchamp, Bouvette-Turcot, Carlson & Carrier, 2013; Bernier, Carlson, Bordeleau et al., 2010). Infant sleep problems have also been relatively highly correlated with more negative temperament traits (DeLeon & Karraker, 2007; Hayes, McCoy, Fukumizu, Wellman & Depietro, 2011; Spruyt et al., 2008) and have predicted later attentional problems (O'Callaghan et al., 2010).

Given these links between sleep and other aspects of temperament and later outcomes it is surprising that more researchers have not investigated sleep as part of the broader self-regulation construct within infancy. The originators of temperament research, Thomas and Chess (1977) developed a *rhythmicity* scale which attempted to measure the regulation of sleep and hunger cycles and bowel movements, and was considered to help define the 'difficult' (low rhythmicity) child from the 'easy' (high rhythmicity) child. This has subsequently been dropped by most temperament researchers due to unsatisfactory internal reliability (Rothbart, 1981). Researchers who have continued to use the rhythmicity scale, consider it to measure the temperamental dimension of reactivity, rather than behavioural regulation (Sanson et al., 2009). It therefore appears that while there may be historical and theoretical grounds to suggest that early sleep problems fit well as indicators of self-regulation within a developmental perspective over time, it remains to be empirically investigated. This project addresses this gap by investigating the feasibility of using short parent-reported measures of sleep regulation, emotional and cognitive regulation together to investigate early childhood self-regulation as a whole.

2.3.2 Implications for the structure of self-regulation in the current study

While this section has attempted to make clear the various components involved in the broad concept of self-regulation, it is evident visually from Figure 2.1, and from the discussion above, that the behavioural, emotional and cognitive domains have significant overlap. One leader in the field recently acknowledged the "ultimate futility of the emotion-cognition dichotomy" (McClelland et al., 2010, p. 511). Similarly other leaders in the field have recently conceptualised self-regulation as the interface of cognitive and emotional development and have suggested that children's self-regulatory processes are organised in an interdependent fashion such that physiological, attentional, emotional, behavioural, cognitive and social processes are all implicated and linked within the broad concept of self-regulation (Blair et al., 2010).

In line with these views, some researchers have chosen to investigate self-regulation as a broad construct that is simply observable at multiple interrelated levels (Jahromi & Stifter, 2008). These researchers have found that competence in each of the three regulation domains was related to performance in each of the other domains at the age of four and a half years and argue for further study into self-regulation as a whole. Evidence for a one-factor broad measurement model of self-regulation, in preference over two- or three-factor models has also been found (Raffaelli & Crockett, 2005). In examining the studies reviewed as part of the systematic literature review, it is clear that most researchers agree with the inter-relatedness of the self-regulation domains. Less than half of the papers chose to focus on only one domain of self-regulation, with the rest studying at least two, if not all three of the self-regulation domains together.

Furthermore, there is an apparent disconnect in the research literature between the study of infant regulatory behaviours such as sleeping patterns, and later measures of self-regulation. As mentioned above, there do appear to be historical and theoretical grounds, and some related empirical work, to suggest that early sleep problems fit well as indicators of self-regulation within a developmental perspective over time, however, this has largely not been investigated. The current research will seek to address this issue by treating the *biobehavioural indicator* of sleeping problems as part of the broader *behavioural self-regulation* construct and including these in investigations of self-regulation across early childhood.

In doing so, the current program of research takes a holistic approach to understanding self-regulation and agrees with McClelland and colleagues (2010) that distinctions between the behavioural, emotional and cognitive domains of self-regulation may be ultimately futile. In taking this holistic approach, the current research makes a significant contribution to practice knowledge for interventionists in the field of early childhood and family support. It is unlikely that such field workers would have the time or resources to distinguish between the various components of self-regulation. Rather, workers in these fields are required to make efficient but reliable and valid judgements on the extent to which children's overall regulatory capacity is of concern and is impacting on their adjustment in order to provide the required support.

2.4 Measuring Self-Regulation

The ways that researchers measure self-regulation largely fall into four distinct categories: teacher, parent or carer report on established questionnaires; tests designed to assess aspects of self-regulation, generally conducted in laboratories; observation of the child in a naturalistic setting or during a natural task by trained observers who code relevant behaviour; and, physiological measures taken with biomedical measurement equipment. This section will discuss the ways in which self-regulation has been measured in the systematic review papers, the benefits and limitations of each, and the implications for the current study.

2.4.1 Parent, teacher or carer report

The most common method of collecting data on children's self-regulation skills is through parent report (usually mother), with carer and teacher report also used at times. Table 2.1 details the parent-, carer- and teacher-report measures used in the literature reviewed. Some studies have used these alone (e.g., Kim & Deater-Deckard, 2011) or in combination with other types of measures such as laboratory assessments (e.g., Olson et al., 2011). Most of the measures used stem from the temperament paradigm with the *Infant, Early Childhood* and *Childhood Behaviour Questionnaires* developed by Rothbart and colleagues prominent (Rothbart, 1981; Rothbart, Ahadi, Hershey, & Fisher, 2001).

The *Childhood Behaviour Questionnaire* (CBQ) is widely used and is designed for children from 3 to 7 years of age. It consists of 15 scales, loading on to three factors (negative affectivity, extraversion / surgency and effortful control). The effortful control factor is most commonly used to measure self-regulation and includes the following scales (examples provided): *attentional focussing* ("when picking up toys usually keeps at the task until it's done"); *inhibitory control* ("can lower his/her voice when asked to do so"); *low intensity pleasure* ("rarely enjoys just being talked to"); *perceptual sensitivity* ("notices the smoothness or roughness of objects s/he touches"); *smiling / laughter* ("laughs a lot at jokes and silly happenings"; Rothbart et al., 2001). These do appear to widely represent the three broad domains of self-regulation previously discussed: behavioural regulation (i.e., *inhibitory control*), emotional regulation (i.e., *smiling / laughter*), and cognitive regulation (i.e., *attentional focussing*).

In the *Infant Behaviour Questionnaire* (IBQ; Rothbart, 1981), designed for children aged up to 12 months, the six scales do not as clearly tap self-regulation, and certainly not each of the three broad dimensions of self-regulation, perhaps due to the difficulty in measuring these constructs at such an early age. Cognitive regulation is somewhat tapped by the scale *duration of orienting* (the child's attention on a single object for an extended period of time when there are no sudden changes in stimulation). Emotional regulation is tapped by the *smiling / laughter* scale as per the CBQ, but behavioural regulation does not appear to be well measured in the IBQ. The original tested version of the IBQ drew from the work of Thomas and Chess (1977) and included a *rhythmicity* scale which attempted to measure the rhythmicity of sleep and hunger cycles and bowel movements, however this was dropped from the IBQ when it was found to have unsatisfactory internal reliability.

A second group of temperament measures developed by Sanson and colleagues do include Thomas and Chess's (1977) rhythmicity scale. The *Revised Infant Temperament Questionnaire, Toddler Temperament Scale* and *Child Temperament Questionnaire* (Prior, Sanson, Oberklaid, & Northam, 1987; Sanson, Prior, Garino, & Oberklaid, 1987; Sanson, Smart, Prior, Oberklaid, & Pedlow, 1994) have found and used a five factor approach to temperament that does include rhythmicity and so could be construed as measuring behavioural regulation. However the authors themselves consider the rhythmicity scale to reflect the broad temperament dimension of *reactivity*, along with the scales of irritability, cooperation, and activity at various age points (Sanson et al., 2009). It could be considered that a number of these scales would provide early indications of emotional regulation, given that emotional regulation is considered to comprise of elements of both reactivity and regulation of emotion (Blair et al., 2010). So in this group of measures, both emotional regulation and behavioural regulation may be represented, but are not clearly defined as such, while the *persistence* and *distractibility* scales included from age one, clearly tap cognitive regulation.

Other parent-, teacher- and carer-report items used stem from the developmental psychopathology and education fields and include the impulsivity scale of the *ADHD Rating Scale* (DuPaul, Power, Anastopoulos, & Reid, 1998), the *Behaviour Problems*

Index (Peterson & Zill, 1986), the *Emotional Regulation Checklist* (Shields & Cicchetti, 1997) and the *Social Skills Rating System* (Gresham & Elliot, 1990). The use of these measures which appear at face value to measure outcomes for children, highlights the inherent difficulties in measuring and studying self-regulation which arise due to the conceptual, theoretical and measurement overlap between self-regulation and internalising and externalising behaviour problems. For example Kim and Deater-Deckard (2011) used items related to inattention from the *Child Behaviour Checklist* as a measure of self-regulation (positioned as a moderator between dispositional anger and outcomes), while simultaneously using the same instrument to measure behavioural and emotional problems (outcome measures). Ramani and colleagues (2010) used various scales of the *Social Skills Rating System* as measures of self-regulation (predictor) and a measure of competence with peers (an outcome measure) within the one study. These researchers also used items that might be considered to be behavioural outcomes such as defiance and compliance to index dysregulation and regulation respectively. The CBQ has also recently been used as both an indicator of self-regulation skills (situated as a predictor; Olson et al., 2011) and as an outcome measure (anxiety problems) when lab tests were used to measure self-regulation as the predictor (White, McDermott, Degnan, Henderson, & Fox, 2011). Calkins (2004) understands these measurement issues by conceptualising behaviour problems (consistently linked with aspects of early temperament) as simply distal indices of self-regulation, rather than as distinct from the dimension of self-regulation itself.

One approach to overcoming such measurement issues adopted by some researchers has been to have an expert panel comment on the face validity of items in the measure in terms of what they are most accurately tapping, and then removing all items that could be confounded on the predictor / outcome side (Belsky et al., 2007). Kim and Deater-Deckard (2011) also took a noteworthy approach to developing a measurement model for self-regulation by selecting items from a number of established measures, based on their face validity in tapping their constructs of interest, inattention and anger. It appears then that there is not one measure that comes even close to perfectly representing self-regulation across all its domains from infancy to middle childhood. Rather, researchers must choose the measures that most parsimoniously and reliably reflect their theoretical and conceptual position on self-regulation and meet the requirements of their research goals and characteristics of their research participants.

Using parental-report measures only is often cited as a limitation in various studies (Blandon, Calkins & Keane, 2010; Pesonen et al., 2008). This is due to the fact that issues of single-rater bias may be introduced, and that the objectivity of parents' observations of their child may come into question. Some researchers have found correlations between maternal report of child temperament and self-regulation with laboratory measures to be non-significant (Seifer, Sameroff, Dickstein, Schiller, & Hayden, 2004; White et al., 2011), suggesting that either there is significant bias and measurement error present in maternal report, or that the parental report and laboratory measures are in fact tapping different aspects of self-regulation, as suggested by White and colleagues (2011). Others have found support for the validity of parent-report measures. For example, Pauli-Pott and colleagues found that maternal report on the IBQ strongly predicted infants' observed temperamental characteristics four months later (Pauli-Pott, Mertesacker, Bade, Haverkock, & Beckmann, 2003). Overall, multi-method measurement designs are considered to be a stronger research design (Eisenberg et al., 2011), with the use of parent-report measures only considered a limitation to be acknowledged and addressed. However parent-report measures have the benefits of being simple to administer and lower in resource and time requirements than other measures such as laboratory assessments

Table 2.1 *Parent-, carer- and teacher- report measures of self-regulation*

Ages used	Measure	Self-regulation aspect measured	Example items	Example papers from systematic review
5 – 56 months	Interview with Paediatrician	Regulatory problems	Crying, eating and sleeping problems as reported by parents. Regulatory problems score computed.	Schmid et al., 2010
0 – 3 years	*Infant Behaviour Questionnaire* (IBQ) (Rothbart, 1981) and *Infant Behaviour Questionnaire Revised (IBQ-R)* (Gartstein & Rothbart, 2003)	Effortful control, attentional control, orienting regulation, duration of orienting	Mothers indicate on a 7-point scale how frequently their infants respond to specific events by fussing, crying, or no reaction during the previous week (e.g., when placed in a car seat—limits, or when exposed to a loud noise—novelty).	Bridgett, et al., 2011; Crockenberg, Leerkes, & Jó, 2008; Pesonen et al., 2008
Birth to age 1 1 – 3 years ≥ 3 years	*Revised Infant Temperament Questionnaire (RITQ)* (Carey & McDevitt, 1978) *Toddler Temperament Scale (TTS)* (Fullard, McDevitt, & Carey, 1978) *Child Temperament Questionnaire (CTQ)* (Thomas & Chess, 1977)	Attention regulation	Parent rates on a 6-point scale the degree to which children display behaviours (from almost never to almost always) e.g. Plays with toy for over one minute (infant); stays with a routine task (dressing, picking up toys) for 5 minutes or more (toddler); likes to complete one task or activity before going on to the next (child)	Sanson et al., 2009
2 – 5years	*ADHD Rating Scale* (DuPaul et al., 1998)	Inattention; reactive control	The impulsivity items include 'blurts out answers', 'difficulty awaiting turn', and 'interrupts/intrudes on others'. Mothers rate the frequency (ranging from never to always) with which they observe their children engage in each item asked.	Hill et al., 2006; Graziano et al., 2010
3 – 7 years 18 months – 3 yrs	*Child Behaviour Questionnaire* (CBQ) (Rothbart et al., 2001) *Early Childhood Behaviour Questionnaire* (ECBQ) (Putnam, Gartstein, & Rothbart, 2006)	Effortful control; inhibitory control Effortful control; orienting regulation & duration of orienting	'Sits still when told', 'lowers one's voice', 'stops activities when asked'. Response scale as per IBQ. Parents rate on a 7-point Likert-style format ranging from never to always the frequency of specific child behaviours (e.g., how often did your child 'sit quietly and watch'; 'become sadly tearful') in various contexts (e.g., 'When being dressed or undressed', 'When playing outdoors', 'When told no')	Bridgett et al., 2011; Olson et al., 2011; Bridgett et al., 2011; Eisenberg et al., 2010; Pesonen et al., 2008
4.5 – 8.5	*Behaviour Problems Index* (Peterson & Zill, 1990)	Self-regulation	Mothers reported how well each item described their child's behaviour in the last 3 months, using a 3-point	Colman, Hardy, Albert, Raffaelli, & Crockett,

Ages used	Measure	Self-regulation aspect measured	Example items	Example papers from systematic review
years			scale: 1 (often true), 2 (sometimes true) and 3 (not true). For e.g. 'he/she has sudden changes in mood or feeling' (affect regulation); 'he/she has difficulty concentrating'' (attention regulation); 'he/she is restless or overly active, cannot sit still' (behavioural regulation).	2006
≥ 2 years	*Emotional Regulation Checklist* (Shields & Cicchetti, 1997*)*	Emotional regulation	23 items rated on a 4-point Likert scale indicating how frequently the behaviours occur. Emotion regulation subscale: e.g. 'displays appropriate negative affect in response to hostile, aggressive or intrusive play' and 'is a cheerful child'. Negativity subscale: 'exhibits wide mood swings and 'is easily frustrated'.	Blandon, Calkins, Grimm, Keane, & O'Brien, 2010; Blandon, Calkins & Keane, 2010; Blandon et al., 2008; Brown, 2010
54 months	*Social Skills Rating System* (SSRS; Gresham & Elliot, 1990).	Regulation (compliance); dysregulation (defiance)	Maternal Compliance Ratings subscale: follows your instructions, attends to your instructions, and follows household rules ; The Maternal Defiance Ratings subscale: controls temper in conflict situations with you, disobeys rules or requests, ends disagreements with you calmly	Ramani et al., 2010
4.5 - 11 years	Mother , father and teacher report on items with face validity related to attention from: *Child Behavior Checklist (CBCL); Teacher Report Form (TRF;*Achenbach, 1999)*; CBQ* (attentional focusing subscale)*; Social Skills Rating System* (SSRS, Gresham & Elliott, 1990)- 1 parent-rated and 1 teacher-rated item	Inattention	CBCL and TRF: can't concentrate, fails to carry out assigned tasks, inattentive CBQ: attentional focussing subscale SSRS: completes tasks within a reasonable time; attends to instructions	Kim & Deater-Deckard, 2011

2.4.2 Laboratory tests

Laboratory tests designed to test children’s self-regulation skills under conditions in which these skills need to be employed are also a common method used in research in this area. Table 2.2 provides examples of some of the laboratory measures used in the review studies. These are generally used from 18 months of age onwards and tend to put children in situations that elicit frustration, resistance to temptation, or delay of gratification, thus testing the self-regulation skills of individuals. Researchers have used laboratory tests alone to measure self-regulation (e.g., White et al., 2011) or in combination with parent or carer report (e.g., Olson et al., 2011).

Laboratory tests are used to measure a wide range of the domains and finer aspects of self-regulation including effortful control, inhibitory control, executive functioning, emotional regulation and attentional control and shifting. Prominent examples of these tests include the *Day-Night Stroop* (Gerstadt, Hong, & Diamond, 1994) and items from the test battery developed by Kochanska and colleagues (Kochanska, Murray, Jacques, Koenig, & Vandegeest, 1996). In the *Day-Night Stroop,* children are asked to say "day" whenever a black card with the moon and stars is shown and to say "night" when shown a white card with a bright sun, thus suppressing a dominant response for a subdominant one. An example from the Kochanska battery includes *Snack Delay* which requires a child to wait for the experimenter to ring a bell before retrieving a chocolate from under a glass cup. Halfway through the trials the experimenter lifts the bell without ringing it, requiring the child to effortfully delay their learned response. A common test for emotional regulation is *Unwanted Gift* (Graziano et al., 2010) in which children are presented with an unwanted prize, after choosing their favourite and least favourite items from a range of toys, thus requiring them to suppress a dominant emotional response (disappointment) in favour of a more socially adaptive one.

Laboratory tests have the benefit of being considered more objective than parent-report measures, however they do require considerable resources and willingness of research participants to attend labs and complete tasks. These kinds of tests may also be considered to be somewhat unrelated to naturalistic, real life situations and are also generally only able to be used from 18 months of age, largely precluding examination of self-regulation during infancy via this method. Some have made arguments for the validity of parent-report measures (Pauli-Pott et al., 2003; Pesonen et al., 2008) and indeed they may be the only measure practical in the first year of life. As noted in the above section, multi-method measurement of self-regulation is considered to provide the most accurate and robust measurement of the construct (Eisenberg et al., 2011).

Table 2.2 *Laboratory measures of self-regulation*

Ages used	Measure	Self-regulation aspect measured	Example items	Outcome of interest	Example papers from systematic review
≥ 18 months	*Kochanska Behavioural battery* (Kochanska, et al., 1996) *Laboratory Temperament Assessment Battery – Locomotor Version (Lab-TAB)* by Goldsmith & Rothbart (1999, cited in (Gagne & Goldsmith, 2011)	Effortful control; inhibitory control	*Snack Delay:* child is offered a snack but is required to wait for a signal to eat it *Dinky Toys:* child is asked to select just one toy from a container holding many attractive toys, inhibiting response to select more than one.	Behaviour coded by trained observers to create a score related to self-regulatory behaviours / abilities	Gagne & Goldsmith, 2011; Jahromi & Stifter, 2008; Jennings et al., 2008; Kochanska, Philibert, & Barry, 2009; Olson et al., 2011 Ramani et al., 2010
≥ 18 months	Working memory and categorization tasks	Executive functioning	*Hide the pots* – a sticker is hidden under 1 of 3 pots and then a blanket placed on top. The child must hold the placement of the sticker in memory to retrieve it. *Categorization* – children must sort baby and grown animals into appropriate boxes	Number of correct responses scored	Bernier et al., 2010
≥ 2 years	Emotion regulation strategies checklist during frustration or other task	Emotional regulation	Children are presented with an *unwanted prize* or a frustrating task (something out of reach) and coded for each 10 sec interval via a checklist of regulation strategies including attention refocusing, comforting, and cognitive reframing.	Mean score on each strategy.	Graziano et al., 2010; Hill et al., 2006; Jahromi & Stifter, 2008; Morris et al., 2010;
≥ 4 years	*Day-Night Stroop* or similar (Gerstadt, et al., 1994)	Effortful control; Inhibitory control	Children are asked to say "day" whenever a black card with the moon and stars appeared and to say "night" when shown a white card with a bright sun.	Children's response accuracy or percent correct over a number of trials, indicating an ability to repress a dominant response	Graziano et al., 2010; White et al., 2011
4 years	*Dimensional card change sort (DCCS)* (Frye, Zelazo & Palfai, 1995)	Attention shifting	Children are presented with two sorting boxes with a model card mounted on the back wall of each of the boxes and are first trained to sort a set	Accuracy score.	White et al., 2011

Ages used	Measure	Self-regulation aspect measured	Example items	Outcome of interest	Example papers from systematic review
			of cards according to one dimension (i.e., colour) and are then trained to sort according to a second dimension (i.e., shape).		
54 months –10 years	Continuous performance tests	Attentional control	The task requires children to press a button whenever a target stimulus appears on a computer screen.	Accuracy score on test tallied by computer.	Belsky et al., 2007; Jahromi & Stifter, 2008
6 – 8 years	Persistence to task	Effortful control	Children are shown a box that contains a puzzle and has a clear back so that the child's hand movements can be observed. A cloth covers the front of the box and has sleeves that the children slip their arms through. This cloth can be lifted up so that the child can cheat by looking at the puzzle. Children are told to assemble the puzzle without looking at it and that if they finish the puzzle within an allocated time they will receive an attractive prize.	Persistence score calculated by from the percentage of time the child remained on task and not cheating.	Spinrad et al., 2006

2.4.3 Observation measures

Observation and coding or rating of children's behaviour by trained observers is another way that self-regulation is measured, although it is not used as frequently as parent report and laboratory based tests. Observational measures appear to attempt to combine the benefit of observing children in relative naturalistic settings with the objectiveness of a third party observer, but are resource and time intensive. A common situation in which children and their parents are placed is the *Clean Up Task* (e.g., Ramani et al., 2010) which allows investigators to observe both how parents direct their children and how children respond, with compliance considered to reflect competent regulation and defiance considered to reflect dysregulation. On and off task behaviour in classroom and childcare settings is also often observed by investigators in an effort to tap effortful and attentional control. Observation measures were used from the age of 18 months in the review papers. Table 2.3 provides examples.

Table 2.3 *Observational measures of self-regulation*

Ages used	**Measure**	**Aspect measured**	**Example items**	**Outcome of interest**	**Examples from systematic review**
18 – 42 months	*Infant behaviour record* – attention and persistence – general measure of behaviour across lab visit.	Effortful control;	'consistently off task or lacks persistence' rated 1 through to 'continued absorption in toy or consistently persistence' rated 5	Composite score	Eisenberg et al., 2010
36 – 54 months	*Clean Up Task* and similar parent-child interaction tasks	Regulation; dysregulation	Children are observed in a 5 minute clean up task with their parent, following a free play session. Observers rate how often behaviours of interest occur (e.g., compliance, non compliance)	Compliance (regulation) and defiance (Dysregulation) composite scores	Hoffman, Crnic, & Baker, 2006; Ramani et al., 2010
4.5 - 11 years	*Classroom Observation System* – inattention subscale	Inattention	Records on / off task behaviour and interactions with others in the classroom	Included in composite 'inattention' score alongside parent and teacher report measures	Kim & Deater-Deckard, 2011

2.4.4 Physiological measures

In recent years, a group of researchers have begun to examine physiological measures of self-regulation in infancy and early childhood. This work has been developed on the basis of Porges' polyvagal theory which describes the maturation of the parasympathetic nervous system, and its key role in the regulation of state, motor activity, attention and emotion (Dale, O'Hara, Keen, & Porges, 2011; Porges, 2009, 2011). It is noted that individual differences in such nervous system functioning are likely to mediate the expression and regulation of emotion, and as such are important in understanding positive social adjustment.

Calkins and colleagues are leaders in the examination of self-regulation through the lens of polyvagal theory, with five of their recent works in this area included in the systematic literature review (Blandon et al., 2008; Calkins et al., 2008; Degnan et al., 2008; Nelson et al., 2012; Perry et al., 2013). Specifically, these studies examined activity in the parasympathetic branch of the autonomic nervous system, from the age of 2 years, measured by baseline and changes in respiratory sinus arrhythmia (RSA). RSA refers to the variability in heart rate that occurs at the frequency of breathing, and is thought to reflect the parasympathetic influence on heart rate variability via the vagus nerve. Levels of baseline, or resting, vagal tone are considered to reflect a stable individual characteristic in the absence of challenge (Blair et al., 2010). However, during situations where self-regulation or coping is required, the vagal input of the heart is withdrawn and a decrease in RSA is observed, permitting sustained attention and other coping behaviours. As such, RSA withdrawal is considered to be a physiological indicator of an individual's ability to engage in self-regulation (Porges, 2009, 2011).

Measurement of RSA involves placing electrodes on a child's chest, which transmit to a vagal tone monitor that computes and displays RSA (vagal tone) every 30 seconds. Baseline data are collected followed by data collected during a task that challenges self-regulation, such as the delay of gratification or frustration tasks described in the previous section. Subtraction of RSA during the task from baseline RSA provides researchers with a score. Positive change scores result when there is a decrease from baseline to the frustration episode, reflecting attempts to regulate emotion. Negative change scores occur when there is an increase from baseline to frustration, reflecting a lack of physiological regulation. In general it has been found that children who have higher resting RSA, and exhibit greater vagal withdrawal during challenging situations are likely to exhibit a greater ability to self-regulate, better sustained attention, fewer behavioural problems and generally more adaptive functioning (Calkins et al., 2008; Calkins, Graziano, & Keane, 2007; Calkins & Keane, 2004).

2.4.5 Implications for measurement in the current study

The above exploration of the ways in which the various components of self-regulation have been recently measured leads to a number of implications for the design of the current research. Only a fifth of the studies in the review used data from the first year of life, although this became more common in very recent years. Only one of these examined at least the first seven years longitudinally (Sanson et al., 2009), with a further four examining the first five years of life (Barnes, Boutwell, Beaver, & Gibson, 2013; Kochanska, Philibert, & Barry, 2009; Pesonen et al., 2008; Schmid et al., 2010). The current research addresses this gap by examining the development of self-regulation from infancy to age 5 in relation to outcomes at age 7.

It appears from the literature review, that while effortful control and related regulatory concepts are well measured by parent report on temperament measures from the age of 12–18 months, the three broad constructs within self-regulation are not well represented in parent-report measures during the first year of life, with behavioural self-regulation particularly absent. However, researchers from outside of the temperament paradigm such as Schmid and colleagues have used infant crying, sleep disturbance and feeding problems as indicators of regulatory problems that have been found to be predictive of later cognitive and behavioural outcomes (Schmid et al., 2010; Schmid, Schreier, Meyer, & Wolke, 2011; Wolke, Schmid, Schreier, & Meyer, 2009). It appears then that temperament researchers may have largely decided on the futility of measuring self-regulation by parent report as a broad concept in infancy, with measures of effortful control beginning at 18 months (Putnam, Gartsten, & Rothbart, 2006), while developmental psychopathology researchers have taken a behavioural approach to measuring regulatory problems as evidenced by sleeping, crying and feeding issues in infancy, their antecedents and sequelae. However, the two theoretical frameworks have not been brought together and this has resulted in a disconnection in self-regulation research across the early years, from infancy to age 5.

The current study addresses this disconnection by including a range of measures related to self-regulation in the exploration of self-regulation across the first five years. As a secondary data analysis of a large longitudinal data set, the investigator must rely on the original measurement design, which in this case is focussed on parent report. However, for the first time, this study will address the extent to which biobehavioural indicators and temperament indicators are cross-sectionally and longitudinally related to each other from infancy to 5 years. The blending of these two approaches from two relatively distinct paradigms affords a greater understanding of the concept of self-regulation from infancy across childhood. The limitations of using parent report alone are also acknowledged and will be discussed in relation to the findings.

2.5 Development of Self-Regulation: Prenatal Period to Middle Childhood

Like most areas of child development, self-regulation is thought to develop most rapidly and crucially in the first five years of life and is conceptualised as involving the acquisition of an integrated set of mechanisms (across a number of domains), that build upon each other over time (Calkins & Williford, 2009). Initially, many aspects of self-regulation are the responsibility of caregivers (e.g., when an infant is hungry the caregiver must feed it and when an infant cries, a caregiver must soothe it). However a major task for children over the early years is to take over and internalise the tasks of self-regulation (McClelland et al., 2010). The degree to which the capacity to develop these skills is largely driven by biology and temperament, or able to be significantly influenced by the environment around the child, is still the topic of much debate and research, with results inconclusive. Going hand in hand with this inquiry are investigations into the relative stability or instability of self-regulation skills across the early years, and across the lifespan.

Biological influences on self-regulation are evident as early as the prenatal period. Recent research has found consistent evidence for the programming effect of maternal stress during pregnancy on the developing foetus, and the infant’s subsequent regulatory capacity (Sandman, Davis, Buss, & Glynn, 2011). Davis and colleagues found that a larger infant cortisol (a stress hormone) response to the heelstick procedure was associated with exposure to elevated concentrations of maternal cortisol during the late second and third trimesters (Davis, Glynn, Waffarn, & Sandman, 2011). Additionally, a slower rate of behavioural recovery from the painful stress of the heel stick was predicted by elevated levels of maternal cortisol early in pregnancy as well as prenatal maternal psychosocial stress throughout gestation. Similar results indicating the influence of maternal anxiety and stress during pregnancy on the regulatory capacity of infants measured through general crying and fussing behaviours have also been found (Bolten, Fink, & Stadler, 2012; Coplan, O'Neil, & Arbeau, 2005).

Others examining the contribution of biology to self-regulation have investigated genetic factors. For example, genetic variation in particular genes has been related to positive affect (COMT gene), negative affect (SNAP 25 gene) and effortful control (CHRNA4 gene) from 6 to 20 months of age (Sheese et al., 2009). Further, a specific genotype 5-HTTLPR polymorphism (specifically, having a short allele, *ss* or *sl)* has been associated with diminished self-regulatory capacity from the ages of 2 to four and half years (Kochanska et al., 2009). However, the risk was only significant for children who were insecurely attached to their mothers at the end of the first year, pointing to the role of the proximal environment, and its interplay with genetic predispositions in determining outcomes for children. This finding is an example of support for the *genetic vulnerability hypothesis* in which beneficial environments buffer children from risks conferred by genotypes, but do not ameliorate the risk entirely. Further support for the biological influences on the development of self-regulation is found in the group of studies examining vagal regulation, which have found that higher resting RSA in infants is linked with better self-regulation skills and better developmental outcomes over time (Calkins et al., 2007; Calkins et al., 2008; Calkins & Keane, 2004).

Leading temperament researcher Mary Rothbart considers that the very first behavioural mechanism by which infants attempt to self-regulate is through the orienting of their attention to particular objects (Rothbart, Sheese, et al., 2011). Individual differences in the ways infants orient their attention to particular stimuli (and are able to shift their attention away from negative stimuli) are found as early as 4 months of age and have been linked with lower negative emotionality (Sheese et al., 2009) and growth in effortful control from 4 to 18 months of age (Bridgett et al., 2011). The orienting network appears then to play an important role in early self-regulation, and involves the inferior and superior parietal areas of the brain as well as the frontal eye fields (Rothbart, Sheese, et al., 2011). Also at around 6 months of age, biological functioning such as sleep-wake and eating cycles become more predictable, with implications for self-regulation (Calkins, 2004). Over the course of the first year of life, infants become more active in the pursuit of self-regulation by using thumb-sucking and other motor behaviours, as well as their growing attentional control abilities to actively self-soothe.

In the toddler and preschool years effortful control is thought to come into strong play as it undergoes considerable development, emerging at the end of the first year of life, and able to be reliably measured by 18 months of age (Putnam et al., 2006). The ongoing maturation of attentional control systems is considered to provide the foundation for effortful control during this time. Measures of effortful control have also been positively inter-correlated with other major developmental areas such as theory of mind from 3 to 6 years of age (Olsen, 2011), suggesting a foundational role for effortful control in the development of more higher order and complex cognitive processes from early to middle childhood.

Leading and oft cited author in the area of self-regulation development, Kopp, notes that the growth in these skills is strongly linked with the development of other domains such as motor, language, cognitive and social skills (Kopp, 1982, 1989, 1991). Development in these other domains allows children to develop a greater repertoire of coping strategies that can be employed when self-regulation is required. Indeed, behavioural and cognitive self-regulation are considered to undergo significant growth during the preschool period when children are increasingly faced with situations in which compliance and executive function skills are required (Calkins & Williford, 2009), and when more complex language and social skills are able to be employed. Therefore self-regulation must always be considered in light of the broader development of the individual.

Individual differences in the indices of self-regulation are found from as early as the immediate postnatal period, and the degree to which these individual differences are stable across early childhood or not varies with the construct measured and the interpretation of results. Self-regulation capacity is thought to stabilise from middle childhood when the developmental process of gaining these skills is largely complete

(Raffaelli & Crockett, 2005), with correlations of across time regulation measures tending to increase from the age of 6 years. Moderate correlations are generally found from 2 to 5 years (approx .5), with these tending to increase for some self-regulation measures only to .6 – .7 from the age of approximately 6 years. Research on the correlations of self-regulation measures prior to the age of 2 years is more sparse with Pearson's *r* during this period usually lower (approx .3; Sanson et al., 2009). These indicative correlation values hold for a wide range of self-regulation measures including vagal suppression (Calkins & Keane, 2004) and self-regulation as measured by the *Behaviour Problems Index* (Colman, Hardy, Albert, Raffaelli, & Crockett, 2006), the *CBQ* (Rothbart et al., 2001), and the *Emotion Regulation Checklist* (Ostrov, Murray-Close, Godleski, & Hart, 2013).

It appears then that there may be a moderate degree of stability of individual differences in self-regulation, however, the degree of stability increases with age, reflecting developmental models in which self-regulation skills increase rapidly over the first three to five years. For example, in one study, longitudinal stability coefficients for effortful control as measured by the *ECBQ* increased with age from 6 to 36 months of age, ranging from .56 to .7 (Putnam et al., 2006). Data gathered from the *Infant, Toddler and Childhood Temperament Questionnaires* produced similarly increasing Pearson's correlations across the time span from 4 months to 8 years (.33 to .73), with variation across scales (Sanson et al., 2009). In a study that used physiological markers of emotional reactivity and regulation, Perry and colleagues (2013) found reactivity to be relatively stable from the ages of 3 to 5 years, but physiological regulation improved in a linear fashion over this time. This suggests that while the reactivity component of self-regulation may reflect an underlying temperamental or biological trait, the regulation component is responsive to developmental change over time.

With correlations of generally only moderate values, it is clear then that there are likely to be a range of extra-individual or environmental factors accounting for the growth of self-regulation over time that must be considered. In particular children's early interactions with caregivers are strongly implicated. It is generally agreed that genetic factors are likely to place particular children at risk of non-normative self-regulatory development, but that the dynamic interplay between childrens' constitution and their caregivers' behaviours will shape the ongoing developmental trajectory (Blair et al., 2010). For example, an infant who is highly reactive from birth may elicit negative responses from parents over time who find the difficult-to-soothe infant frustrating, and awkward to interact with. This infant will not get the opportunity, through co-regulation experiences with his/her caregiver, to experience positive regulation, and practice the skills required for self-soothing over time. Alternatively, the highly reactive infant who experiences parents who persist in co-regulation attempts, and provide the context within which the infant receives positive feedback, is more likely to begin to build a repertoire of self-regulatory skill. Thus individual in-born propensities can be shaped by proximal environmental factors.

2.5.1 Neurobiology and self-regulation

Recently, neuro-imaging technology has allowed for the study of the development of self-regulation in terms of brain structure. A hierarchical process of brain function development is implicated, with initial brain stem functioning considered crucial in very early life (Geva & Feldman, 2008). The brain stem is implicated in the regulation of basic physiological functions such as sleep patterns and other early sub-cortical, and biologically driven, mechanisms of arousal and attention. After 3 months of age, the maturation of the collicular-basal ganglia, posterior attention systems, hypothalamus and thalamus are implicated in the coordination of self-regulation. Very premature or low birth weight infants are considered to be at greater risk for self-regulatory disorders, at least in part due to the incomplete maturity and growth in the brain stem area (Geva & Feldman, 2008).

The development of higher order cognitive control abilities which are able to influence reactivity levels are considered to be primarily cortical in origin (Blair et al., 2010) and in particular are related to the ongoing maturation of the prefrontal cortex across early childhood (McClelland et al., 2010). In particular, beginning in the second year of life, the anterior cingulate is consistently implicated in executive attention and self-regulation and has been found to show a strong increase in connectivity to frontal areas of the brain, with connectivity continuing to increase over childhood (Rothbart, Sheese, et al., 2011). The anterior cingulate continues to play a vital role in integrating cognitive and emotional information systems, and therefore self-regulation, across the lifespan.

2.6 Self-Regulation as a Predictor of Outcomes

A large body of research has examined the relationships between self-regulation skills and social, emotional and behavioural outcomes for children. Typically these studies find that poorer self-regulation skills are associated longitudinally with problems relating to peers (Blandon, Calkins, Grimm et al., 2010; Olsen et al., 2011; Schmid et al., 2010), poorer social skills (Sanson et al., 2009) and higher levels of externalising and internalising behaviour problems (Belsky et al., 2007; Degnan et al., 2008; Hill et al., 2006; Kim & Deater-Deckard; Morris et al., 2010; Wang, Deater-Deckard, Petrtill, & Thompson, 2012). These findings extend throughout the lifespan with poorer self-regulation skills during early childhood associated with more externalising behaviour problems and risk-taking in adolescence (Honomichl & Donnellan, 2012) and higher rates of adult social problems including gambling (Slutske, Moffitt, Pouton, & Caspi, 2012). Very few studies in the systematic review examined outcomes for children with better self-regulation skills, but those that did found that these children had more positive peer relations than those with poorer self-regulation skills (Blair et al., 2013; Ramani et al., 2010; Sylvester, 2007) and experienced less teacher-child conflict in the early school years (Fitzpatrick & Pagani, 2013). These types of findings are generally replicated across regulatory domains and measures including effortful control (Bassett, Denham, Wyatt, & Warren-Khot, 2012), attentional control (Kim & Deater-Deckard, 2011), biophysiological regulatory indicators in infancy (sleeping etc; Schmid et al., 2010) and emotional regulation indices (Blandon, Calkins & Keane, 2010). While these results are regularly and consistently replicated, research also indicates that pathways between regulatory capacity and outcomes are not free of context and that transactional processes present can influence outcomes.

For example, while Olson and colleagues (2011) found that lower levels of effortful control predicted children’s concurrent level of peer aggression (at age 3) and later levels of peer aggression at school entry (age five and a half to 6 years) as hypothesised, findings in support of a complex child-environment transformational process were also found. Self-regulation was a key contributor to levels of peer aggression at age 3, but didn’t predict changes in peer aggression at the transition to school, whereas corporal punishment used by parents *did* predict heightened aggressive responding in children. The authors speculate that while developmental deficits such as poor self-regulation play a key role in the origins of children's aggressive behaviours in the first three years of life, it is in fact environmental risk factors such as parenting that then become the primary predictors of children's later risk status as they enter the schooling years (Olson et al., 2011).

There is also evidence that different components of self-regulation may interact with each other such that the transactional effects of the components taken together influence outcomes for children. For example Degnan and colleagues (2008) examined profiles of disruptive behaviour in children aged 2 to 5 years and identified four behaviour profiles: high, moderate, normative and low. The high profile group had consistently high levels of disruptive behaviour bordering on clinically concerning at age 5. The moderate group had moderate levels of disruptive behaviour across the measurement period. The normative group had moderate levels at age 2, declining to low levels at ages 4 and 5. The low group had low levels of disruptive behaviour across the time period. The investigators used both observed reactivity to a frustrating event and physiological regulation (RSA) at age 2 as predictors in examining group membership. Of note, it was found that when children were high in observed reactivity (generally considered a risk factor for behaviour problems), physiological regulation was a protective factor leading them to be more likely to be in the normative, rather than high / moderate groups. This and similar findings reinforce the need for researchers to consider a broad cross-section of self-regulatory indices in examining their relationships to later competency. Simple correlational pathways from high early reactivity to later behaviour problems are not always supported when the influence of children's developing self-regulatory skills are carefully considered.

2.7 Self-Regulation as a Moderator or Mediator of Outcomes

While most of the studies reviewed included measures of self-regulation as predictor or outcome variables, many also examined the moderating and mediating role of self-regulation, with this approach becoming more common in very recent years. The broad idea in this area stems from theory that self-regulation may act as the major moderating or mediating mechanism between early infant reactivity (considered largely genetic / temperamentally driven) and later personality and adjustment. Theoretically, children with high temperamental reactivity, who develop strong self-regulation skills in spite of this, may be able to ‘over ride’ their natural reactivity to some extent in order to better function in day to day interactions. These children would therefore be expected to have better social, emotional and behavioural outcomes than highly reactive children who do not develop a strong capacity to self-regulate. Researchers have therefore tested ways in which various components of self-regulation may act as protective factors, and for which children, with complex results that are not always in the anticipated direction.

An example of such research is that undertaken by White and colleagues (2011), who examined how two processes indicative of regulation (attention shifting and inhibitory control) differentially influenced the risk of anxiety symptoms for children with high levels of behavioural inhibition (often exhibited by shyness and linked to later anxiety problems). Results showed that, as expected, children with higher levels of behavioural inhibition at 24 months were more likely to display anxiety symptoms at preschool, however attention shifting and inhibitory control differentially moderated this link. High levels of attention shifting were a protective factor, thought to be due to these children’s ability to flexibly shift attention away from any perceived emotional threats, thus regulating their own proclivity to respond negatively. High levels of inhibitory control, usually associated with improved adaptation for most children, actually put children with high behavioural inhibition at further risk of anxiety problems. Explanations for this included the fact that children high in behavioural inhibition tend to be highly vigilant and constantly evaluating their own performance. If these children are also high in inhibitory control, they may not be able to flexibly engage their control processes, resulting in rigid and over controlled behaviours that only lead to further anxiety (White et al., 2011).

Emotional regulation has emerged as a particularly important moderator in recent research. Dollar and Stifter (2012) found specific emotional regulation strategies to moderate the relationship of early temperamental surgency to peer and social problems. Highly surgent children who employed social support seeking as an emotional regulation strategy during a frustrating task were less likely to have problems with peer aggression. Biederman and colleagues (2012) found deficient skills in emotional regulation to reliably identify a sub-group of children with ADHD diagnoses who were likely to have the most negative psychiatric and social outcomes and most persistent disability in relation to ADHD. Findings such as these point to the need for researchers to consider children’s self-regulation skills in each domain in relation to each other domain, and as part of the moderating or mediating process from early temperament or risk status to later outcomes.

While it is typically understood that negative aspects of parenting such as insensitivity tend to lead to poorer outcomes for children, aspects of self-regulation may also have a role in mediating and moderating the parenting environment. For example, Belsky and colleagues (2007) found that attentional regulation mediated the relationship between parenting and externalising behaviour problems. Attentional control was measured during a laboratory test at 6 years of age and was found to partially mediate the effect of insensitive parenting at 54 months on externalising problems at 8 years, and also mediated the effect of parental sensitivity at 6 years on problem behaviour at 10 years. These findings held when earlier measures of parenting, attentional control and problem behaviours were controlled for. Spinrad and colleagues (2012) found effortful control to mediate the relationship between maternal sensitivity and children’s later compliance. Troxel and colleagues (2013) found that emotional regulation moderated the relationship between attachment security, sleep problems and later behaviour problems. These relationships were significantly stronger for infants with higher levels of negative emotionality suggesting that these infants are more highly susceptible to positive and negative attachment environments.

Recent research has also found evidence for the buffering effect that self-regulation skills provide children in the context of environmental risk such as socio-economic disadvantage (Dilworth-Bart, 2012; Derauf et al., 2011). Findings such as these further reinforce the role of children’s self-regulation skills as part of a dynamic, transactional system. In these systems self-regulation can variously take the role of predictor, mediator, moderator and outcome in relation to proximal environmental factors around the child including the parenting environment.

2.8 Children’s Self-Regulation and Parenting

This section explores the research to date regarding the interactions between children’s self-regulatory skills and parenting. The section is organised into three subsections. The first considers parenting behaviours in relation to self-regulation, the second considers parental mental health and the final section explores the child-driven effects of children's regulatory capacity on parenting.

2.8.1 Parenting behaviours

Much research effort has been devoted to investigating the links between various aspects of parenting behaviours and children's self-regulation skills. Given that the growth of self-regulation occurs at least as early as from birth, it does so in most cases within the proximal environment created by the parent-child relationship. Indeed, a major task over the first three years of life is for children to gradually depend less and less on their caregiver to regulate and co-regulate their behavioural, emotional, and cognitive states, and to take on this responsibility (and gain the skills to do so) for themselves. Therefore the degree to which parents provide an optimal environment within which this can occur is likely to have an impact on the development of self-regulation skills and associated outcomes for children.

Overall, researchers have found that high maternal control and harsh discipline is negatively associated with children's ability to self-regulate and high maternal warmth and sensitivity is positively associated (Graziano, Calkins, & Keane, 2011; Nelson et al., 2012; Olson et al., 2011; Spinrad et al., 2012). For example, Graziano and colleagues (2010) found that high maternal control at age 2 negatively predicted effortful control at age five and a half, and was also related to lower levels of reactive control growth over the same period. It is likely that within a highly controlling parental environment, children have limited opportunities to practice self-regulation skills in situations that are mindfully scaffolded by the parent. On the other hand, high maternal warmth at age 2 positively predicted children's effortful control at age five and a half years (Graziano et al., 2010). Maternal support for emotional development when children were 5 years old predicted positive changes in emotional regulation skills in children two years later (Blair et al., 2013). Even when earlier self-regulation skills (Belsky et al., 2007; Colman et al., 2006), cognitive development, socio-economic status and gender (Jennings et al., 2008) are controlled for, longitudinal associations between maternal warmth and sensitivity and children's self-regulation skills tend to hold. It is likely that mothers who tend to be warm and sensitive with their children are able to provide the necessary support and scaffolding required for children to begin to grapple with their individual levels of reactivity and practice the processes of self-regulation.

Other aspects of parenting have also been found to be associated with children's self-regulation skills. For example Bridgett and colleagues (2011) found that toddler effortful control at 18 months of age was predicted by maternal effortful control and maternal time spent in interactive caregiving activities when the infant was 6 months old. These findings suggest that the more opportunities infants have to interact with caregivers, the greater their exposure to experiences that promote the emergence of self-regulation skills in toddlerhood through the parent-infant relationship. In terms of the relationship between maternal effortful control and child effortful control, it may be that there are genetic factors relevant here, and / or role modelling and teaching effects.

Further highlighting the role of the parent-child relationship, Calkins and colleagues (2008) found evidence that the quality of parent-child relationships influences the development of regulatory skills even at the physiological level (often considered a stable biological trait) from the ages of 2 to 5 years. In this study higher levels of relationship dysfunction between mother and child were associated with lower levels of physiological regulation in children during a challenging situation. These relationships held even when accounting for prior physiological regulation and early and concurrent behaviour problems. Furthermore, regardless of the level of dysfunction present in the relationship, children showed higher levels of physiological regulation when working on a task with their mother, than when working independently, even at over 5 years of age. This finding suggests that the main caregiver has a significant ongoing role to play in supporting the practice of regulatory skills, even after the critical first five years of life have passed (Calkins et al., 2008).

While many studies find results that concur with the above general view of the influence of parenting on children's self-regulation skills, one study included in the review found no similar evidence for links between parenting style and emotional regulation (Higgins, 2008). Others do not find results in the expected direction, but rather find differential results for children based on their self-regulation profile. For example, in a study examining the predictors of belonging to low or high disruptive behaviour profile groups, in children aged 2 to 5 years, Degnan and colleagues (2008) found no effects for maternal control alone. Although it was hypothesised that children with highly disruptive behaviours would have mothers who were more controlling, and children with low disruptive behaviours would have less controlling mothers, the evidence did not support this view. However, differential effects for controlling maternal behaviours were found for children with varying levels of reactivity and physiological emotional regulation. Children with high reactivity plus a highly controlling mother were more likely to be in the highly disruptive behaviour group, as were children with low physiological regulation and low maternal control.

Taken together, the authors suggest that these findings indicate that maternal control is in fact a protective factor for children low in physiological regulation, but a risk factor for children displaying high reactivity (Degnan et al., 2008). In a related finding, Jennings and colleagues (2008) reported that maternal warmth was more important for the development of self-regulation when toddlers had less understanding of agency, and less important for children who had higher levels of understanding of agency. In addition, infants high in anger were found to be more highly susceptible to the positive effects of maternal warmth in relation to the development of self-regulation skills later in early childhood (Razza, Martin, & Brooks-Gunn, 2012). These studies join a group of research that has begun to establish a body of evidence that suggests that parenting style interacts differentially with various child temperaments to produce particular outcomes for children (Belsky, Hsieh and Crnic, 1998; Stright, Gallagher & Kelley, 2008). Once again, these findings indicate the importance of considering self-regulation within a transactional and relational developmental systems perspective.

2.8.2 Parent mental health

While the links between maternal mental health and parenting behaviours (Waylen & Stewart-Brown, 2010) and maternal mental health and child outcomes (Choe, 2012; Goodman et al., 2011), are widely established, and a large body of literature examining the relationships between parenting behaviours and children's self-regulation exists, there are surprisingly few studies examining the links between parental mental health and children's self-regulation. Prenatal maternal mental health has received attention recently due to emerging evidence for the foetal programming effect that the presence of maternal stress hormones might have on children prior to birth. One such study included in the systematic literature review found that prenatal stress experienced by mothers at 29 weeks gestation, along with their self-efficacy, predicted greater crying and fussing in their 6-week-old infants (Bolten et al., 2012). Other recent studies confirm this effect and find consistent evidence for the programming effect of maternal stress during pregnancy on the developing foetus, and the infant's subsequent regulatory capacity (Sandman, Davis, Buss, & Glynn, 2011).

A further four papers included in the systematic literature review examined parental mental health in relation to children's self-regulation with divergent results found. Blandon and colleagues (2008) found that fewer maternal depression symptoms predicted mothers reporting greater increases in children's emotional regulation skills over time, however Jennings and colleagues (2008) found that maternal depression played no role in the development of self-regulation (laboratory assessed) from 20 to 34 months of age. Pesonen and colleagues (2008) found that maternal stress in infancy led to a decrease in attentional focussing, soothability and negative affectivity in childhood at age 5, as hypothesised. Roben (2012) found maternal depressive symptoms to predict toddler emotional regulation in a cohort of adoptive parents. Taken together with the foetal programming literature discussed above, these provide evidence for both biological and environmental effects in relation to maternal mental health and a child's developing self-regulation.

Cross-sectional studies provide additional information on the possible relationships between maternal mental health and children's self-regulation. Hoffman, Crnic and Baker (2006) found that depressed mothers (when compared to non-depressed mothers) provided less effective scaffolding and had children with higher levels of observed dysregulation and parent-reported behaviour problems (both father and mother report) at 4 years. Similarly, Hughes and Ensor (2009) found that individual differences in four-year-old problem behaviour scores showed significant independent associations with executive dysfunction, and maternal depression, even after controlling for gender, verbal ability and maternal education. In addition, executive dysfunction mediated the relationship between maternal depression and problem behaviours such that higher self-regulatory abilities served as a protective factor for children with maternal depression.

It appears then that research regarding self-regulation and maternal mental health is relatively rare, with longitudinal designs even more scarce. However, some further elucidation of the possible associations in this area can be found in the broader body of research examining child temperament. Even in this field, studies of the kind are scarce and it is not typical for causal pathways to be established, leaving many unanswered questions about the directionality of child temperament to parent mental health and reverse effects. In a cross-sectional study of three- to four-year-old children in a community sample, Olino, Klein, Dyson, Rose and Durbin (2010) found that higher levels of child negative emotionality were associated with higher probability of parental depressive disorders, however causal pathways could not be detected. Another cross-sectional study found that parents with higher depressive vulnerability rated their children's temperament more negatively at 5 years of age, and again, causal pathways could not be established (Pesonen, Räikkönen, Heinonen, Jarvenpää, & Strandberg, 2006). In one of the few longitudinal studies, Gartstein and colleagues (2010) found that greater maternal depression in infancy predicted steeper increases in infant's fearfulness (a construct associated with temperament) in the first year of life, and that steeper increases in fearfulness predicted increased toddler anxiety problems. Recent Australian research found that parents with more irritable infants reported lower levels of self-efficacy and had infants with more problems when toddlers. Parents who reported their infants as high in the approachability and cooperation scales of infant temperament felt more efficacious and reported their toddlers as having fewer problems (Zimmer-Gembeck & Thomas, 2010). The extent to which these findings reflect parent-driven models of influence or child-driven models (or both) is unknown.

Most researchers investigating parent mental health and child temperament or child self-regulation interactions appear to favour a parent-driven theory. For example, Pesonen and colleagues (2006) propose that repeated exposure to parental self-criticism and other behaviours indicative of poor parental mental health during sensitive periods for development may lay the foundation for future negative self-schemas in the child. It may also be that children of parents with poor mental health inherit a genetic susceptibility (perhaps temperamental) to less positive affective states and poorer self-regulatory capacity given that children of depressed parents have a heightened risk for future depression (Olino et al., 2010). In fact one key hypothesis posits that the nature of the intergenerational transmission of depression involves a temperamental vulnerability on the part of the child (Olino et al., 2010). It is foreseeable that similar findings relating specifically to self-regulation may be found, however to date there are very few longitudinal examinations of its relationship to parental mental health. The current research project represents a significant contribution in this area by testing longitudinal models that include repeated measures of child self-regulation and maternal mental health across the first seven years of life.

2.8.3 Child-driven effects

Transactional models of development acknowledge the possibility of child-driven effects on parenting and parent mental health (Pesonen et al., 2008; Sameroff, 2009). However, there is very limited empirical investigation, particularly longitudinally, that investigates these effects. Eisenberg and colleagues (2010) recently found that children's effortful control at 18 months and 3 years predicted mother's use of teaching strategies one year later, with the reverse association not shown. This provides evidence that mother's prior knowledge of children's self-regulation skills comes in to play as mothers choose the coaching strategies to use with a child on a difficult task. Mothers used more cognitive and questioning based techniques with children who had higher effortful control a year ago and more directive techniques when children were previously lower in effortful control (Eisenberg et al., 2010). In a related finding Belsky and Park (2000) found that children's inhibited behaviour was likely to increase specific parental reactivity to such behaviour, but the reverse effects of parenting on children's behaviour were not found.

Only two longitudinal studies examining child-driven effects (temperament or self-regulation) were found. Barnes and colleagues (2013) found that children's low self-regulation at 2 years of age was predictive of parents use of corporal punishment two years later. Pesonen and colleagues (2008) found that higher infant activity level predicted decreased maternal stress in childhood but found no child-driven effects for other measures such as effortful control. In contrast, a parent-driven effect of maternal stress on the development of effortful control was indicated.

Additional attempts to find empirical evidence for the bidirectional effects within the parent-child system can be found in the literature on the developmental trajectory of behaviour problems. Choe (2012) recently examined maternal mental health and children's behaviour problems in relation to transactional theories of development. While mother-driven effects were found fairly consistently, he was unable to find child-driven effects in the sample as a whole. Child-driven effects did emerge in a sub-group of children who were reported by their mothers to be more highly regulated infants (less fussing, crying and better sleeping patterns). This may have been because mothers of more highly regulated infants might have attributed later behaviour problems more to their own parenting than to the nature of the child and therefore experienced more detrimental effects on their mental health (Choe, 2012). In contrast to this finding, Bagner and colleagues did find rare empirical evidence for the bidirectional effects between maternal depressive symptoms and children's behaviour problems across the period from 4 to 7 years (Bagner, Pettit, Lewinsohn, Seeley, & Jaccard, 2013).

Taken together, it is clear that although transactional theories of child development have been popular in the social sciences, there are very limited instances of empirical evidence, particularly for child-driven effects. The findings to date in relation to parent mental health and child self-regulation are very limited and inconclusive in nature. The current program of research addresses this issue by examining bidirectional relationships between self-regulation and maternal mental health across the first seven years.

2.9 Implications for the Current Research

A conceptual model developed to guide the current program of research is presented in Figure 2.2 below. This model depicts the multiple domain approach taken to the measurement of self-regulation (behavioural, emotional and cognitive) and the hypothesised bidirectional effects of children's self-regulation skills and maternal mental health from birth to age 5. These relationships will be explored and the associated social, emotional and behavioural competencies for children at age 7 will be investigated. The role of maternal parenting in the pathway from early self-regulatory ability to later outcomes for children will also be investigated.

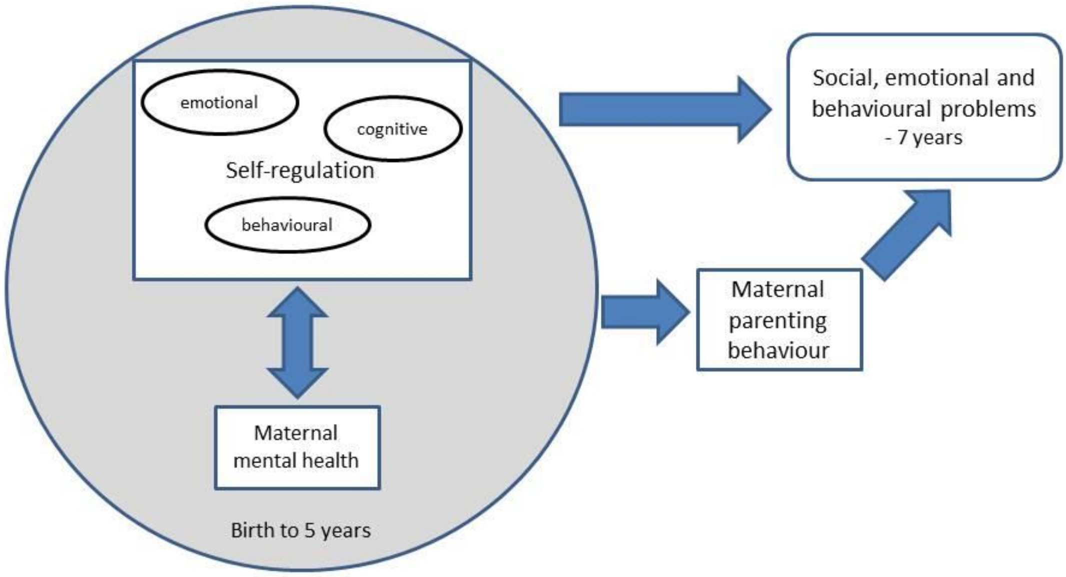

Figure 2.2. Conceptual model for the current research.

The body of research investigating children's self-regulation skills, their antecedents and sequelae has grown significantly in recent years. While much is known about the protection and risk conferred by self-regulation profiles in regards to children's social, emotional and behavioural development, and the ways in which parenting is associated with such, there are still a number of gaps in the knowledge. The current program of research is designed to address many of these by way of conceptual, measurement, design and sample considerations.

There appears to be a growing movement towards the conceptualisation of self-regulation as a broad construct encompassing a range of hierarchical domains of regulation development (Blair et al., 2010; McClelland et al., 2010), however there is limited empirical work that examines the relationships among various components of self-regulation across the early childhood period. Rather, researchers have tended to continue to focus on the finer grained aspects of self-regulation. The current study will address this by investigating the relationships among measures of behavioural, emotional and cognitive regulation at three time points from infancy to age 5.

While measures of self-regulation that tap each domain are well established from the age of approximately 18 months, representing each domain in the measurement of self-regulation in infancy has proved difficult. The study of biobehavioural indicators such as sleeping and eating problems in infancy, and their conceptualisation as signalling early regulatory problems, offers the self-regulation researcher an extended measurement dimension to consider. To date, longitudinal research designs have not attempted to connect infant biobehavioural patterns (e.g., sleeping) with broader parent-reported self-regulatory dimensions across early childhood, leading to a startling disconnect in the research literature. The current program of research addresses this by considering infant sleep behaviours as an indicator for self-regulation in the first year of life. The blending of these two approaches from two relatively distinct paradigms may afford a greater understanding of the concept of self-regulation from infancy across childhood.

In taking this approach to self-regulation, the current research aims to be readily transferable into practice knowledge for interventionists in the field of early childhood and family support. Field workers are required to make efficient but reliable and valid judgements on the extent to which children's overall regulatory capacity is of concern and is impacting on their adjustment with generally only parent-report data available. The measurement models developed in the current research provide the basis for the identification of a group of 'red flags' that may be used by practitioners in the field to identify children and families at the greatest risk of poor self-regulation, and in turn, poorer outcomes.

Only one of the studies included in the review included data from the first year of life in a longitudinal design covering birth to age 7 (Sanson et al., 2009). Given that the first five years of life are considered the critical developmental period for the growth of self-regulation skills, it is essential that trajectories of such and influencing factors such as parenting are more thoroughly explored longitudinally across this time frame. Additionally, there are no studies to date that provide specific information on the normative developmental path for early childhood self-regulation in Australian children. The current study will address this by examining self-regulation and parenting from birth to age 5 and relationships to outcomes at age 7, when social, emotional and behavioural competencies are crucial to success in the early school years. It will also extend current knowledge relevant to the Australian context by using a large (larger than almost all of the review studies) sample of Australian research participants.

While a significant body of research documents the relationships between maternal parenting behaviours and children's self-regulation, there are very limited studies exploring associations with maternal mental health and even fewer which examine the reciprocal and longitudinal relationships between these components. Further research on the links between children's self-regulation skills and maternal mental health in particular is clearly warranted, especially during the early childhood period when regulatory skills may be most susceptible to change, and where the relevant studies are most limited. Maternal depression is a vital aspect to consider not only because of the detrimental health effects for the mother but because of the potential for poor parental mental health to compromise positive parenting and child development. The current research will investigate the mother-to-child and child-to-mother effects of children's self-regulation skills, parenting behaviours and maternal mental health over the first five years of life within a transactional model of child development.

2.10 Conclusion

Self-regulation is a key construct within developmental psychology and refers to the processes that serve to modulate an individual's reactivity in the behavioural, emotional and cognitive domains. It is considered to be the key mechanism by which early, biologically driven temperament develops into later personality, and as such has been the subject of much research, particularly in recent years. Under-developed self-regulation skills have been associated with a range of poorer life outcomes including internalising and externalising behaviour problems. Better self-regulatory capacity has generally been linked with social competence and fewer behavioural problems.

While the structure of self-regulation is reasonably established and agreed upon, the ways in which it is best measured are somewhat varied, and are particularly limited in infancy. There is substantial evidence to suggest that the proximal parenting environment has an important influence on children's ability to self-regulate, however most of these studies have focussed on parenting behaviours, with limited examination of parent mental health. Furthermore, most studies investigated only parent-driven effects, even though transactional systems perspectives of human development suggest the possibility of child-driven effects on parenting factors. Very little is known about the normative self-regulation developmental pathway for Australian children from birth to age 5, particularly when self-regulation is viewed as a multi-dimensional construct observed at a number of levels and across a number of domains. Similarly, there are no studies to date that investigate the association of such longitudinal pathways with later social, emotional and behavioural competencies in Australian children. Given the key role of self-regulation in positive outcomes across the lifespan, further research that can provide critical information to parents, early childhood professionals and the designers of early intervention and prevention programs and policy is warranted.

The current program of research addresses these gaps in the current body of knowledge through four studies. The first investigates measurement models that reflect each of the domains of self-regulation from birth to age 5, and documents the longitudinal relationships among these. The second study develops evidence for the longitudinal and reciprocal associations between children’s self-regulation and maternal mental health, and the extent to which early childhood self-regulation predicts behavioural problems in the early school years. The third study examines the extent to which particular maternal parenting behaviours are implicated in the pathway from early self-regulation to later social, emotional and behavioural competency for children. The fourth and final study establishes the normative pathway for self-regulation development in Australian children aged birth to 5 and identifies the early indicators of deviation from this normative path.

Through these analyses, this program of research makes a substantial contribution to contemporary understandings of early childhood self-regulation. Particular strengths include an emphasis on the Australian context, a large sample size, empirical testing of transactional models of child development in relation to maternal mental health, and utilisation of contemporary statistical modelling techniques. The following chapter will provide further details on the sample, measures and analysis approaches used for the study.

CHAPTER 3: RESEARCH DESIGN AND METHODS

3.1 Introduction

The aim of this program of research is to investigate the developmental pathways of self-regulation from birth to age 5, and the ways in which maternal and mental health interact with children's growing self-regulatory capacities to produce particular social, emotional and behavioural outcomes for children at age 7. In particular, the use of early sleep regulation indicators, along with temperamental persistence and reactivity measures, in longitudinal models of self-regulation from birth to age 5 will be explored. The longitudinal and reciprocal relationships between maternal mental health and children's regulatory capacity will be investigated and the role of maternal parenting in the path from early self-regulation to later outcomes will be investigated. Finally, the longitudinal profiles of early childhood self-regulation development will be examined allowing for the description of a normative pathway for Australian children, and identification of the early signs of deviation from this normative path.

This program of research involves the analysis of data collected from the *Growing Up in Australia: The Longitudinal Study of Australian Children* (LSAC; Edwards, 2012). The longitudinal nature of the LSAC dataset, which focuses on child development from birth, allows for a more thorough understanding of the ways children grow over time and the factors that influence such. Secondary data analysis of such large longitudinal datasets allows researchers to investigate questions which would otherwise be too time-consuming or expensive to pursue (Smith et al., 2011). In turn, it increases the informational value of the data by expanding the research returns from the substantial investment in data collection (Friedman, 2007). There are also a number of challenges associated with secondary data analysis, and these will be further discussed in the following section.

This chapter will present a brief discussion on the use of longitudinal data sets and will provide information on LSAC including design, sampling and procedures. Detailed information on the sample selection procedure and the characteristics of the sample included in the current study will then be provided. The LSAC variables selected for use in the current study will be described in detail. The approach to analysis methodology and missing data is described. The four research questions that make up the current research project and brief details on the associated methodology for each will then be outlined. The research questions are: (1) What are the relationships among parent-reported sleeping problems, temperamental reactivity and temperamental persistence over the first five years and what do they tell us about early childhood self-regulation? (2) How is self-regulation from birth to age 5 associated with maternal mental health across time and children's social, emotional and behavioural outcomes at age 6-7? (3) Is the relationship between children's self-regulation during the third year and child behavioural outcomes in the seventh year moderated or mediated by maternal parenting and mental health measured in the fifth year? (4) What are the longitudinal profiles of self-regulation in children aged birth to 5 and how are they related to child outcomes and parenting?

3.2 Secondary Analysis of Longitudinal Datasets

Secondary analysis of large longitudinal datasets has become more common in recent years as more national governments fund such research in an effort to better inform policy and practice (Trzesniewski, Donnellan, & Lucas, 2011; Vartanian, 2011). Several advantages of secondary data analysis as a methodology have been discussed in the literature. These include the ability to efficiently address a research question that may have otherwise been prohibitively expensive and time consuming without access to existing datasets (Hofferth, 2005). Over time, researchers are also able to replicate and reinterpret existing research using the same dataset (but perhaps different measures or subsamples), thus developing the field of inquiry in a more substantial and sophisticated fashion than might be possible with smaller one-off, stand- alone studies (Friedman, 2007). Secondary analysis also provides opportunities for novice or early career researchers to gain skills in complex analysis and statistical methodologies that require large samples and measurement of multiple constructs, building research capacity in data users and within the field (Smith, 2008). Secondary analysis also has the social and economic benefits of not requiring further research participant effort over and above that of the original study. It therefore capitalises on the original research dollar spent on data collection, and the goodwill and effort of research participants.

While the advantages are clear, the challenges associated with secondary data analysis, particularly of longitudinal datasets, need to be carefully considered. There may be incongruence between the available data and the research constructs to be investigated (Hofferth, 2005). In particular, with a broad based survey such as LSAC, while a large range of important developmental and environmental measures may be included in the design, the depth of measurement for any particular construct area may be minimal. Furthermore, large scale survey designers often have to compromise on the measurement instruments used in the interest of efficiency and brevity, leading to the use of often shortened and adapted versions of original validated measurement instruments (Hofferth, 2005). Measures are also likely to change over time, particularly in studies such as LSAC that measure constructs from birth that change in their composition dramatically over the first seven years of life. However, these disadvantages encourage investigators to consider the use of more parsimonious measurement constructs in their work and may also be outweighed by the benefit of obtaining research answers at a very low cost (Friedman, 2007).

The current program of research was designed with these issues in mind. It takes a theoretically driven approach as the primary driving motivation, ensuring that the available data did not drive the research questions. The LSAC measures related to the central concept of self-regulation were not taken at face value but rather subjected to detailed and robust tests of their measurement properties. This process was implemented in order to somewhat address issues related to the use of shortened and adapted versions of standard instruments present within LSAC. It also allows the findings to be more readily transferrable to the early childhood practice environment due to their parsimonious nature. Finally, dealing with missing data, caused both through non-response to particular items at any time point, and attrition of participants over time, is also a priority consideration for investigators using longitudinal datasets (McKnight & McKnight, 2011; Young, Powers, & Wheway, 2007). The approach to missing data used in this thesis is described in Section 3.6.6.

3.3 The LSAC Study

The LSAC is funded by the Commonwealth Department of Social Services (DSS). The study was designed by a multidisciplinary team of leading researchers, in collaboration with key stakeholders and policy bodies. LSAC is currently managed by the Australian Institute of Family Studies (AIFS) in partnership with the Australian Bureau of Statistics (ABS; Edwards, 2012). The overarching research questions guiding the LSAC study are: What are the childhood experiences and conditions that impact on child, adolescent and adult outcomes and on trajectories of development? What are the mechanisms underlying linkages and interactions and how do these change over time? What factors and processes protect children from events or contexts that increase the risk of poor outcomes? (Australian Government Department of Families, Housing, Communities, and Indigenous Affairs, 2009).

The LSAC uses a cross sequential research design. Two cohorts of children are being tracked from 2004, with data collection occurring biennially. A total of eight waves of data collection are currently funded. At Wave 1, the B Cohort (Birth or Infant Cohort) were aged less than one year and the K Cohort (Kindergarten Cohort) were aged 4 to 5 years old. Wave 2 occurred in 2006, Wave 3 occurred in 2008 and Wave 4 data was collected in 2010. This study uses data from the first four waves of the B Cohort as released in 2011 in the first release of the Wave 4 dataset.

The first LSAC technical paper provides a detailed description of the sampling design (Soloff, Lawrence, & Johnstone, 2005). The sampling unit for LSAC is the Study Child, with children selected through use of the Medicare Australia database, considered the most comprehensive database of Australia's child population. A two-stage clustered design was employed. First, 311 postcodes were randomly selected. In the second stage, children were randomly selected from these postcodes resulting in 5107 infants (B Cohort) and 4983 children aged 4-5 years (K Cohort) being selected for the study. A process of stratification was used to ensure that the numbers of children selected were roughly proportionate to the total numbers of children within each state/territory, and within the capital city statistical districts and the rest of each state (Soloff et al., 2005). The cohorts have been found to be largely representative of the Australian population (Gray & Smart, 2009). Appendix C provides a table detailing some of the socio-demographic characteristics of the B Cohort and comparing these with population levels of the same characteristics. Where particular groups were under or over represented, weighting of the data is typically used to ensure that the dataset represents as closely as possible, the larger Australian population from which it has been drawn, and to also account for any attrition between waves (Daraganova & Sipthorp, 2011).

Once selected from the Medicare database, families were contacted with an initial “invitation to participate” package from the AIFS. Families who chose not to ‘opt out’ were then contacted by I-view (subcontracted social and market research company) to arrange an interview time. From Wave 2, the ABS took over responsibility for data collection. Informants used at each wave were Parent 1 (the person who knows the Study Child best), Parent 2, the Study Child him/herself, Parent Living Elsewhere (from Wave 2 on), and teachers and child care workers. Data for each Study Child from relevant national databases were also linked where available. These included the National Childcare Accreditation Council, Medicare Australia, the ABS, the National Assessment Program – Literacy and Numeracy (NAPLAN), and the Australian Early Development Index (AEDI).

The LSAC measures were designed to collect information on multiple areas of child development, health and wellbeing, and the context in which children are raised, particularly their family, child care, school and neighbourhood experiences (Gray & Smart, 2009). The main data collection instruments at each wave for the B Cohort were face to face interviews with Parent 1; a self-complete parent questionnaire (Parent 1 and Parent 2); time use diary; questionnaires for child care workers, teachers and Parents Living Elsewhere; and direct assessments of children’s physical measures. Additionally for the B Cohort, the Who am I (WAI) test for school readiness was conducted at Wave 3, the Peabody Picture Vocabulary Test (PPVT) in Waves 3 and 4, the Matrix Reasoning Test in Wave 4 and a child self-report measure (conducted by interview) was also implemented in Wave 4. Between-wave data collection was also undertaken (Waves 1.5, 2.5 and 3.5) in order to maintain contact with each family and gather further information. These consisted of brief questionnaires examining parent and child health status, general development, children’s use of care and schooling and general family circumstances (Daraganova & Sipthorp, 2011).

Data collected at four time points from a selection of families participating in the Birth Cohort of 5107 children is used to address the research questions in the current project. Wave 1 of data was collected during infancy, Wave 2 at age 2-3 years, Wave 3 at age 4-5 years and Wave 4 at 6-7 years. This enables the construct of self-regulation to be examined over the crucial developmental period of birth to age 5, with its relationship to outcomes as measured at age 6 to 7 years examined. A range of measurement instruments that conceptually, theoretically and empirically relate to self-regulation are used to address the research questions. Relevant aspects of parenting including maternal mental health and concepts of positive and negative parenting are also used. All measures are described in detail in Section 3.5. The following section describes the sample selection procedure and the characteristics of the participants in the current program of research.

3.4 Sample Selection and Description of Participants

In selecting a sample from the full LSAC dataset for the current program of research, a number of issues were considered including the availability of data on key measures of interest and the consistency of the main informant (Parent 1) across the waves. The parent-reported child temperament measures were located in the parent self-complete questionnaire (left behind by the interviewer in Waves 1 and 2), resulting in a relatively large amount of missing data for these measures when parents did not return the form. Therefore, families who did not complete and return that measurement instrument at each of Waves 1, 2 and 3 were not included in the selected sample for the current study. Attrition from the LSAC study across waves also resulted in some loss of participants.

In order to minimise the confounding factors in the study, only biologically related or adoptive mother informants (Parent 1) were selected for inclusion. This is because in Studies 2, 3 and 4 where parenting measures are used, it is important to have consistent informants across the sample as fathers' and mothers' behaviour and mental health have been shown to be differentially impacted upon and in turn influence child development (Roben, 2012). Therefore, parent gender would be a confounding factor in the analysis models. Further research testing similar models with fathers should be undertaken at a later date.

Listwise deletion of participants who did not meet the criteria described above was undertaken resulting in the deletion of 2227 cases. Many leading researchers using the LSAC dataset have taken this approach and as such it has become the norm for LSAC data users (Farrant & Zubrick, 2013; Giallo et al., 2012). As contemporary missing data methodologies become more sophisticated this may change in the future as more options for the treatment of missing data become available.

A total of 2880 participants who had complete leave-behind parent survey data across Waves 1 to 3, completed by the same biological or adopted mother respondent at each wave remained and were selected for inclusion in the current study. The selected sample was tested on key demographic characteristics and participants of the current study were found to differ significantly from those excluded (Table 3.1). The mothers and children selected for this study were less likely to be Indigenous and have a main language other than English. The selected mothers were also slightly older at the initial data collection time and had a higher socio-economic position. The children selected for the study were slightly younger at the Wave 2 and Wave 3 data collection times. These differences between the selected sample and those not included are typical of the patterns of losses experienced in longitudinal studies, and mean that the participants in this study are no longer representative of the full LSAC study and the Australian population. Table 3.1 describes the differences between the LSAC sample and the sample used in this study at Wave 1.

Table 3.1 *Sample demographics of selected and excluded participants*

Individual Characteristics	Sample: Included (*n* = 2880)	Sample: Excluded (*n* = 2227)	Significance	
Child Characteristics	**% (*n*)**		**χ^2**	***p***
Female	48.0 (1392)	49.6 (1105)	.830	.370
Aboriginal or Torres Strait Islander	2.3 (67)	7.3 (163)	72.8	.000
Main language other than English	7.1 (207)	15.5 (345)	89.8	.000
	M (SD)		***F***	***p***
Age Wave 1 (months)	8.7 (2.54)	8.8 (2.61)	1.2	.270
Age Wave 2 (months)	33.7 (2.80)	34.2 (2.84)	33.3	.000
Age Wave 3 (months)	57.4 (2.72)	57.9 (2.74)	39.8	.000
Age Wave 4 (years)	6.33 (.463)	6.31 (.473)	2.414	.120
Parent Characteristics (Wave 1)	**% (*n*)**		**χ^2**	***p***
Aboriginal or Torres Strait Islander	1.2 (35)	5.8 (129)	84.7	.000
Main language other than English	7.2 (207)	15.5 (345)	89.8	.000
	M (SD)		***F***	***p***
Socio-economic position (SEP) Wave 1*	0.2 (.95)	-.25 (1)	269.6	.00
Age Wave 1 (years)	31.9 (4.88)	29.9 (6.04)	173.2	.00

* Socio-economic position is an LSAC derived variable that combines measures of household income, parental education and parental occupational prestige. It has an approximate mean of zero and standard deviation of one (Blakemore, Gibbings, & Strazdin 2009).

3.5 Measurement Instruments

This section provides detail on the specific measurement instruments to be used in the current research. The measures are presented in four sections. The first discusses those items selected to represent self-regulation. The following section details the measures related to parenting. Third, the measures for children's social, emotional and behavioural problems are discussed. Finally, the control variables selected for use in the current program of research are detailed.

3.5.1 Self-regulation measures

Measures related to self-regulation in early childhood were selected from the LSAC dataset following the review of literature conducted for Chapter 2. The aim was to select measures that tapped each of the behavioural, emotional and cognitive domains of self-regulation at each wave of data collection. The LSAC variables were searched for items related to early feeding, crying and sleeping problems as prior research has identified these as an important constellation of behaviours in consideration of early regulatory abilities (Schmid et al., 2010). There were no measures related to crying in LSAC and only a single item in infancy reflected early feeding difficulties, but this was not represented at any other wave. Maternal report of temperament and sleep problems *were* available at each wave of LSAC and have been used in previous studies to reflect self-regulation (Choe, 2012; Schmid et al., 2010; Spinrad et al., 2012). These were therefore selected for use in the current program of research as measures of self-regulation. These variables are summarised in Table 3.2 and further detail on each is provided below. Variable labels used in the LSAC dataset for these items can be found in Appendix D

Short Temperament Scale for Infants (STSI)

The *Short Temperament Scale for Infants* (STSI) was originally developed for the Australian Temperament Project (ATP; Prior, Sanson, & Oberklaid, 1989), by using established items from the *Revised Infant Temperament Questionnaire* (RITQ; Carey & McDevitt, 1978). This saw the original nine factor structure of the RITQ reduced to five factors for the STSI-ATP. This was then further reduced to three factors for the purposes of LSAC. The STSI-LSAC has a total of 12 items, and is designed to assess temperament in children younger than 12 months of age. It is used only in Wave 1 of LSAC. Parents respond to items on a 6-point scale: 1 = *almost never* to, 6 = *almost always*.

The STSI is composed of three subscales: *approach*, which refers to the infant's degree of comfort in new situations or when meeting new people, *cooperation*, how cooperative/adaptable the baby is and *irritability*, how difficult it is to soothe the baby (Sanson et al., 1987). Typically, to score the scale, individual item scores are summed for each subscale with three items reversed as required. Summed scores are averaged to reflect the original scale, with scores ranging from one to six. Higher scores reflect high sociability, high cooperation and high irritability. Sanson and colleagues (1987) investigated the measurement properties of the STSI-ATP (1987) and found that it had moderate internal consistency with a median alpha coefficient of .61 and test-retest reliability of an average of .81. It is unknown to what extent the STSI-LSAC has been tested for its measurement properties as no literature has been found to date on the subject.

Table 3.2 *Summary of self-regulation measures for the current study*

Wave	**Measure**	**Located in**	**Scales – items**	**Response scale**	**Sample item**
1	*Short Temperament Scale Infants* (STSI)	Leave behind questionnaire	Irritability – 4 items	1= *almost never* to 6 = *almost always*	This baby amuses self for ½ hour or more in cot of playpen
	Biobehavioural regulation	Interview	Sleeping problems - 4 items	*Yes / no* on each item	Does your child have any of these problems on 4 or more nights a week: difficulty getting to sleep; not happy to sleep along; walking during the night; restless sleep?
2	*Short Temperament Scale Toddlers* (STST)	Leave behind questionnaire	Persistency – 5 items	1= *almost never* to 6 = *almost always.*	This child goes back to the same activity after a brief interruption
			Reactivity – 4 items	1= *almost never* to 6 = *almost always*	This child responds to frustration intensely
	Biobehavioural regulation	Interview	Sleeping problems - 4 items	*Yes / no* on each item	As per Wave 1
3	*Short Temperament Scale Children* (STSC)	Complete during interview	Persistency – 4 items	1= *almost never* to 6 = *almost always.*	When a toy or game becomes difficult, this child quickly turns to another activity (reverse coded)
			Reactivity - 4 items	1= *almost never* to 6 = *almost always*	When this child is angry about something, it is difficult to sidetrack him / her (reverse coded)
	Biobehavioural regulation	Interview	Sleeping problems - 4 items	Yes / no on each item	As per Wave 1

Although none of the three scales of the STSI-LSAC specifically refer to self-regulation in the infant period, the *irritability* scale was selected for use in this study. This is because it has been noted that reactivity (measured by the irritability scale) can be considered a component of emotional self-regulation, particularly in infancy (Blair et al., 2010). Scores were reverse coded in order for higher scores to reflect lower irritability and potentially higher regulatory skills. The scale was also renamed *reactivity* for the purposes of this study in order to match the names of similar scales used in Waves 2 and 3. A latent variable approach is taken by modelling the latent variable for reactivity as indicated by the four items that make up the scale, rather than creating a composite score as is typically done. The items making up the scale are detailed in Table 3.3.

Short Temperament Scale for Toddlers (STST)

The *Short Temperament Scale for Toddlers* (STST) was also originally developed for the Australian Temperament Project (ATP; Prior et al., 1989), by using established items from the *Toddler Temperament Scale* (TTS; Fullard, McDevitt, & Carey, 1984). The STST-LSAC has a total of 12 items, and is designed to assess temperament in children aged 1 to 3 years. It is used only in Wave 2 of LSAC. As per the STSI, parents respond to items on a 6-point scale: 1 = *almost never* to, 6 = *almost always*.

The STST is composed of three subscales: *approach* which assesses the tendency to approach versus withdraw from novel situations or people; *persistence* which measures the degree of persistence a child displays in completing tasks or activities; and, *reactivity* which assesses the degree of negative reactivity a child displays. Typically to score the scale, individual item scores are summed for each subscale with three items reversed as required. Summed scores are averaged to reflect the original scale, with scores ranging from one to six. Higher scores reflect high approach, high persistence and high reactivity. In an early Australian study using the TTS, the scale was found to have moderate internal consistency with a mean alpha coefficient of .71 (range .55 to .87; Oberklaid, Prior, Sanson, Sewell, & Kyrios, 1990). It is unknown to what extent the STST-LSAC has been tested for its measurement properties as no literature has been found to date on the subject.

For the current study, the *persistency* subscale was selected to tap cognitive regulation while the *reactivity* subscale was selected to tap emotional reactivity and regulation. The scores on the reactivity scale were reverse coded in order for higher scores to reflect lower reactivity and potentially higher regulatory skills. Again, a latent variable approach is taken by modelling the latent variables for reactivity and persistence as indicated by the items that make up those scales. These items are detailed in Table 3.3.

Short Temperament Scale for Children (STSC)

The *Short Temperament Scale for Children* (STSC) was also originally developed for the ATP, following factor analysis (Prior et al., 1989) of the *Childhood Temperament Questionnaire* (CTP; Thomas & Chess, 1977). While the original scale had thirty items, the STSC-LSAC is a 12-item parental/carer report inventory. The STSC is designed to assess temperament dimensions in children aged between 3 and 7 and is used from Wave 3 on in LSAC. Parent responses are on a 6-point scale where *1 = almost never* to *6 = almost always*. The STSC-LSAC consists of the same three subscales as the STST-LSAC which are called *sociability* (previously approach), *persistence* and *reactivity.* The STSC-LSAC is scored in the same way as the STST-LSAC.

The STSC-ATP has been found to have adequate internal consistency, response range, and independence of dimensions and adequate reliability (Cronbach's alpha: Approach = .85, Persistence = .83, Inflexibility = .82; Sanson et al., 1994). Little, Sanson and Zubrick (2012) recently reported internal consistency estimates of the STSC-LSAC that were lower than the STSC-ATP, particularly for reactivity (Approach = .82 in Indigenous LSAC children and .81 in non-Indigenous LSAC children; Persistence = .79; Reactivity = .59 in Indigenous LSAC group and .69 in non-Indigenous children).

For the current study, the *persistency* subscale was again selected to tap cognitive regulation and the *reactivity* subscale to tap emotional regulation. Scores on the reactivity scale were again reverse coded in the opposite direction to the original scale, in order for higher scores to reflect lower reactivity and potentially higher regulatory skills. The same latent variable modelling approach described for Wave 1 and Wave 2 was also taken, rather than creating composite scale scores. The items making up the Wave 3 persistency and reactivity scales are detailed in Table 3.3.

Table 3.3 *Self-regulation items selected from the temperament scales in LSAC*

Wave	**Scale**	**Items**
1	Reactivity	The baby is fretful on waking up and / or going to sleep (frowns, cries) [reverse scored]
		This baby amuses self for ½ hour or more in cot or playpen (looking at mobile, playing with toys etc)
		This baby continues to cry in spite of several minutes of soothing [reverse scored]
		This baby cries when left to play alone [reverse scored]
2	Reactivity	This child responds to frustration intensely (scream, yells) [reverse scored]
		This child has moody “off” days when he/she is irritable all day [reverse scored]
		This child shows much bodily movement (stomps, writhes, swings arms) when upset or crying [reverse scored]
		This child reacts strongly (cries, screams) when unable to complete a play activity [reverse scored]
	Persistence	This child plays continuously for more than 10 minutes at a time with a favourite toy
		This child goes back to the same activity after a brief interruption (snack, trip to toilet)
		This child stays with a routine task (dressing, picking up toys) for 5 minutes or more
		This child practices a new skills (throwing, building, drawing) for 10 minutes or more
3	Reactivity	If this child wants a toy or sweet when shopping, he or she will easily accept something else instead
		When this child is angry about something, it is difficult to sidetrack him/her [reverse scored]
		When shopping together, if I do not buy what this child wants (e.g., sweets, clothing) he/she cries and yells [reverse scored]
		If this child is upset, it is hard to comfort him/her [reverse scored]
	Persistence	When this child starts a project such as a puzzle, he/she works on it until it is completed even if it takes a long time
		This child likes to complete one task or activity before going on to the next
		This child stays with an activity (e.g., puzzle, construction kit, reading for a long time)
		When a toy or game is difficult, this child quickly turns to another activity [reverse scored]

Biobehavioural regulation

Sleep problems were measured by items from The Infant Sleep Study (Bayer, Hiscock, Hampton, & Wake, 2007). The modified items examine specific sleep problems that the study child may suffer, such as sleeping alone, nightmares, waking, unable to get to sleep etcetera. Parents are asked at each wave of data collection to indicate if their child has "any of these problems on four or more nights a week, or more than half the time?" Four items of interest were selected for use in the current study, due to their potential to tap biobehavioural regulation in infants and children (and their consistency across Waves 1 to 3). These were difficulty getting off to sleep at night, not happy to sleep alone, waking during the night and restless sleep. Responses were reverse scored in order for higher scores to reflect a greater capacity to regulate, demonstrated through lower levels of sleeping problems. These items are also used in a latent variable modelling approach to measurement development.

3.5.2 Parenting measures

All parenting measures were mother self-report and so are called maternal mental health and maternal parenting from this point on in the thesis. All were completed by self-complete survey. Maternal mental health as measured at each of Waves 1, 2, 3 and 4 was used in the current study. Maternal parenting measures were selected from Wave 3 only. Table 3.4 provides a summary of these measures and the following text provides more details on the measures and justification for their selection. The LSAC variable labels for these items can be found in Appendix D.

Table 3.4 *Summary of parenting measures for the current study*

Variable	Wave and location of item	Measures	Response scale	Example item
Maternal mental health	Wave1: Leave behind questionnaire Wave 2, 3 and 4: complete during interview	Kessler K6 (6 items)	1 = *all of the time* to 5 = *none of the time*	In the past 4 weeks how often have you “felt hopeless?”
Maternal parenting				
Parenting efficacy	Wave 3: complete during interview	4 items	1 = *never or almost never* to 5 = *almost always*	“I feel that I am very good at keeping this child amused”
Warmth		6 items	1 = *never or almost never* to 5 = *almost always*	“How often do you have warm, close times together with this child?”
Hostility		4 items	1 = *not at all* to 10 = *all of the time.*	“How often have you raised your voice with or shouted at child?”
Anger		5 items	1 = *never or almost never* to 5 = *almost always*	“How often are you angry when you punish this child?”
Inductive reasoning		5 items	1 = *never or almost never* to 5 = *almost always*	“How often do you explain this child why he/she was being corrected?”
Consistency		5 items	1 = *not at all* to 10 = *all of the time*.	“How often does this child get away with things that you feel should have been punished?”

Maternal mental health

The links between maternal mental health and parenting behaviours (Waylen & Stewart-Brown, 2010) and maternal mental health and child outcomes (Goodman et al., 2011), are widely established. Emerging research has also begun to explicate the ways in which maternal mental health and children’s self-regulation interact within the parent-child environment across early childhood (Choe, 2012; Roben, 2012). Still, there is much more to learn in regards to the bidirectional influences that are likely to exist during this period. Maternal mental health was therefore selected as a key variable for investigation in the current study.

Maternal mental health was measured consistently at each data collection point in the LSAC study using the *Kessler K6* screening scale. This measure is designed to detect psychological symptoms and has been widely used in Australian and international population studies (Furukawa, Kessler, Slade, & Andrews, 2003). The K6 consists of six items that ask about the respondents’ feelings over the past four-week period. Items are answered on a five-point scale ranging from 1 = *all of the time* to 5 = *none of the time*. Example items are: over the past four weeks how often “Did you feel nervous?” and “Did you feel everything was an effort?” An overall score was calculated by summing and averaging the total score. Higher scores indicate the presence of more symptoms. In the current study the K6 screener was used as a measure of maternal mental health at each of Waves 1, 2, 3 and 4.

Maternal parenting

Aspects of maternal parenting were selected for analysis from the Wave 3 data only and included warmth, hostility, anger, inductive reasoning, consistency and parenting self-efficacy. Selection was based on prior evidence that similar parenting constructs are significantly associated with children’s developing self-regulation and behavioural problems across early childhood (Blandon, Calkins & Keane, 2010; Graziano et al., 2010; Olson et al., 2011). A composite measure of each of the parenting constructs was calculated using the proportionally adjusted factor score regression weights reported in Zubrick, Lucas, Westrupp and Nicholson (2013). These investigators used structural equation modelling (SEM) to assess items and scales used in the parenting measures included in LSAC. Well-fitting measurement models were then constructed and syntax was provided for the calculation of construct scores that take into account item loadings. Further detail on each of the constructs is provided below.

Warmth was assessed using six items from the *Child Rearing Questionnaire* (Paterson & Sanson, 1999) on which parents rated their expression of physical affection and enjoyment of the child. Each item was rated on a 5-point scale (*never or almost never, rarely, sometimes, often, always or almost always*). Example items include “How often do you express affection by hugging, kissing and holding this child?” and “How often do you have warm, close times together with this child?”

Hostility was measured using adapted items from the Early Childhood Longitudinal Study of Children, Birth Cohort (National Center for Statistics, 2004) and the National Longitudinal Survey of Children and Youth 1998-1999 (Statistics Canada, 1999). The scale consists of five items which are answered on a 10-point semantic differential scale ranging from 1 = *not at all* to 10 = *all of the time.* Example items are:

in the past four weeks “I have lost my temper with this child” and “I have raised my voice with or shouted at this child”.

Anger was measured using adapted items from the National Longitudinal Study of Children & Youth (Statistics Canada, 1999). Each item was rated on a 5-point scale (*never or almost never, rarely, sometimes, often, always or almost always*). Example items are: “How often are you angry when you punish this child?” and “How often do you feel you are having problems managing this child in general?”

Inductive reasoning was measured using five items from the *Child Rearing Questionnaire* (Paterson & Sanson, 1999) on the extent to which mothers used reasoning when managing their children’s behaviour. Each item was rated on a 5-point scale (*never or almost never, rarely, sometimes, often, always or almost always*). Example items include “How often do you explain to this child why he/she was being corrected?” and “How often do you emphasise to this child the reasons for rules?”

Consistency was measured using adapted items from the National Longitudinal Survey of Children and Youth 1998-1999 (Statistics Canada, 1999). The scale consists of five items which are answered on a 10-point semantic differential scale ranging from 1 = *not at all* to 10 = *all of the time*. Example items are: “How often does this child get away with things that you feel should have been punished?” and “How often is this child able to get out of punishment when he/she really sets his/her mind to it?”

Parenting self-efficacy was measured using four items from the Early Childhood Longitudinal Study-Birth Cohort (National Center for Education Statistics, 2004). The items consisted of various statements regarding parental self-efficacy such as “Do you feel that you are good at getting this child to do what you want him/her to do?” Respondents rated the four parenting statements on a 5-point scale ranging from 1 = *never/almost never* to 5 = *always/almost always*.

3.5.3 Social, emotional and behavioural outcome measure

The outcome measure used in this study is the *Strengths and Difficulties Questionnaire* (SDQ; Goodman, 2001). The SDQ is designed to make separate assessments for three groups of problem behaviours: conduct/oppositional, hyperactivity/inattention, and anxiety/depressive. These three groups of problem behaviours are combined to generate an overall measure of behavioural problems (Goodman, 2001). The SDQ is a 25-item, parent-report inventory. It can also be completed by teachers and children themselves. Each item consists of a statement regarding their child's behaviour pattern over the past six-month period. Informants rate how true/typical the statement is of the child's behaviour. Items are answered on a 3-point scale where 1 is "not true", 2 is "somewhat true" and 3 is "certainly true".

The SDQ consists of five subscales: emotional symptoms (5 items), conduct problems (five items), hyperactivity/inattention (five items), peer relationship problems (five items) and prosocial behaviour (five items). The emotional subscale measures various emotional symptoms. Example items are "Often unhappy, downhearted or tearful", "Often complains of headaches, stomach aches" and "Nervous or clingy in new situations". The conduct problems subscale measures the possibility of conduct/oppositional behaviours. Example items are "Often has temper tantrums or hot tempers" and "Generally obedient, usually does what adults request" (reverse scored). Hyperactivity/inattention subscale example items are "Restless, overactive, cannot stay still for long" and "Easily distracted, concentration wanders". The peer problems scale investigates the quality of peer relationships using items such as "Gets on better with adults than with other children" and "Picked on or bullied by other children". The prosocial behaviour subscale measures behavioural strengths in the form of behaviours. Example items are "Considerate of other people's feelings" and "Helpful if someone is feeling hurt, upset or ill".

The questionnaire is scored by summing individual item scores for each subscale. Items are reverse-scored where required. High scores on each subscale represent a greater degree of problem behaviour in that behavioural domain. The exception is the prosocial behaviour subscale, where high scores indicate a high degree of prosocial behaviour. Scores from the four 'problem behaviour' subscales (emotional, conduct, hyperactivity and peer problems) are summed to provide an overall problem behaviour symptom score ranging from zero to 40 (the prosocial behaviour scale is not included in this calculation). This is known as the SDQ Total Problems Score. High scores indicate that a child displays a greater degree of problem behaviour. The SDQ has received extensive psychometric evaluation, revealing strong reliability and validity

(Goodman, 2001; Hawes & Dadds, 2004; Holtmann, Becker, Banaschewski, Rothenberger, & Roessner, 2011).

At Wave 4 of LSAC, the SDQ was completed by Parent 1 (restricted to mothers only for the current study) during the LSAC interviews and was also completed by teachers through a questionnaire. In the current study, the Total Problems Score was computed for both mother and teacher data. Using both informants strengthened the robustness of the analyses by taking a multiple-informant multiple-context approach.

3.5.4 Control variables

History of maternal depression

A significant history of maternal depression for the two years prior to Wave 1 data collection was selected as an indicator of mother's vulnerability to depression. It was used as a control variable throughout analyses due to the large body of literature linking maternal depression with child outcomes (Goodman et al., 2011). Including a history of maternal depression in the current study was also an attempt to partially control for the biological or genetic pathways in relation to self-regulation. It is considered that the ability to self-regulate is at least partially biologically driven with specific genes identified as contributing to individual differences in self-regulatory capacity (Kochanska et al., 2009). The biological transmission of self-regulation is also somewhat supported by an emerging group of studies which indicate that foetal programming occurs when the biochemicals associated with depression and anxiety are present in the mother's system during gestation (Sandman, Davis, Buss, & Glynn, 2011). The measure chosen for this study was a single item which asked the mother at Wave 1, "Have you ever had two or more years in your life when you felt depressed or sad most days, even if you felt okay sometimes?" At Wave 1, this item captured those mothers who had a significant history of depression prior to conception and birth of the study child, eliminating some of the chance that depression related mostly to parenting (e.g., postnatal depression) would be captured.

Socio-economic disadvantage (SED)

The LSAC derived variable for socio-economic position (SEP; Blakemore et al., 2009) was selected as a control variable due to the previously documented associations between socio-economic status and children's self-regulation development (Degnan et al., 2008; Graziano et al., 2010; Hill et al., 2006). For the purposes of this thesis, the SEP variable was reverse scored and labelled *socio-economic disadvantage (SED),* with higher scores indicating lower levels of family income, parental education and occupational status, and therefore higher relative disadvantage. This was done to allow for more easy interpretation of the path models documented in the results chapters. This contributes to a consistent approach to variable scoring by having higher scores on each of the control and outcome variables refer to a hypothesised risk or more negative outcome. Bivariate correlations among SED scores at each of Waves 1, 2 and 3 were high (r = .890 to .917), indicating a high degree of stability in SED across the data collection period. In the interests of parsimony, only Wave 1 SED was included as a control variable.

Gender

Child gender was selected as a control variable given the previously documented differences between boys and girls in relation to self-regulation (Gagne & Goldsmith, 2011; Sanders et al., 2009; Schmidt et al., 2010). Females were coded as zero and males as one.

3.6 Analytic Techniques

The analytic method at the core of the current research is structural equation modelling (SEM). SEM is a contemporary technique more and more commonly used in the social sciences. It typically involves the modelling of latent or unobserved variables to explain variation in groups of measured or observed variables. The primary focus of the estimation process is to yield parameter estimates that minimise the discrepancy between the sample covariance matrix and the population covariance matrix (Byrne, 2012).

There are a number of advantages to SEM techniques. Measurement models for latent variables and structural components related to theory testing can be completed in the same analyses which allows for the modelling of measurement error and more accurate parameter estimates than are gained by standard regression techniques (Kline, 2011). The nature of the analyses also allows path models to be presented. These are useful visual representations of the relationships among variables.

SEM is a broad term denoting a statistical approach to analyses which can include a number of specific approaches. Four approaches are selected for use in the current program of research and all analyses are undertaken using SEM program Mplus Version 7 (Muthén & Muthén, 1998 - 2012). The approaches selected are confirmatory factor analysis (CFA; Study 1), longitudinal panel SEMs (Studies 2 and 3), path analysis (Studies 2, 3 and 4) and latent profile analysis (LPA; Study 4). In both path analysis and longitudinal panel SEMs, mediation is explored. Moderation is also examined in Study 3. This section provides more detail on each of these analytic approaches in turn as well as providing a short discussion on the comparative merits of variable-centred and person-centred analytic approaches and describing mediation and moderation. The general steps taken to conduct the analyses are then described. Finally, treatment of missing data is discussed.

3.6.1 The four key analytic approaches used in this thesis

Confirmatory factor analysis (CFA) is a theory driven technique whereby the researcher explicitly tests *a priori* hypotheses about relations between observed variables (e.g., test scores or ratings) and latent variables or factors (Jackson et al., 2009). It is commonly used in the development and refinement of measurement instruments and for assessing construct validity (Brown, 2006). It is considered a key first step in the estimation of SEMs. Without careful evaluation of the measurement models for the latent variables to be included in subsequent structural models, model misspecification and interpretation of results will be problematic (Brown, 2006). CFA was selected over the related technique of exploratory factor analysis (EFA) in the current study, as the items selected from LSAC to tap self-regulation have been previously and consistently used as part of specific scales of sleep problems, reactivity and persistence. It was not considered feasible to submit this diverse range of items to EFA where the number and type of factors are considered to be unknown.

Longitudinal panel SEMs: SEM has been described as a combination of CFA and multiple regression because it examines the relationships between latent variables by extending the measurement models (essentially the CFAs) into structural models (Schreiber et al., 2006). SEMs can be conducted with both cross-sectional and longitudinal data. Longitudinal panel SEM refers to models in which several variables are measured consistently across at least two time points. These models make it possible to account for the stability of and prior associations between variables and therefore to more accurately examine whether variance in an outcome is better predicted by earlier variance in predictors (Belsky & Park, 2000). These models also allow for mediator (indirect) effects to be explored. Mediation is explained in more detail in a following section.

Path analysis is typically used to refer to SEM models that use only observed or measured variables, rather than latent variables. Path analysis has become popular in the social sciences because it provides a graphical representation of a set of algebraic relationships (regressions) among variables, allows the examination of direct and indirect (mediator) effects, and indicates which predictors have stronger or weaker relationships with the dependent variables (Menard, 2010). While path analysis was previously undertaken by separate regression analyses, contemporary practice has shifted to the use of SEM software which allows for the simultaneous estimation of all relationships within the model (Menard, 2010).

Latent profile analysis (LPA) is part of a group of statistical approaches called finite mixture modelling. This approach is also known as latent class cluster analysis as it is analogous to both latent class analysis and traditional cluster analysis. Latent class analysis refers to this modelling approach when categorical variables are used as indicators, whereas use of the term LPA refers to the use of continuous indicator variables (Collins & Lanza, 2010). LPA is a semi-parametric group based approach that allows for the estimation of qualitatively different groups when group membership cannot be observed *a priori*. Longitudinal LPA has been recently used by researchers in developmental science to explore developmental pathways when longitudinal measurement invariance is not possible (e.g., Degnan et al., 2011). As opposed to techniques which investigate intercepts, slopes and trajectories of development, longitudinal LPA does not require the variables to be measured in the same way at each data collection point. This was an important distinction and choice in the current research as the LSAC measures change over time to reflect the developmental stages of child research participants.

3.6.2 Variable-centred and person-centred approaches

The CFAs, SEMs and path analyses used across this thesis can be described as variable-centred approaches. The ways in which relationships between variables are modelled in these approaches is based on the assumption that associations found hold for each individual within the research population. In contrast, the LPA conducted for Study 4 represents a person-centred approach. This approach tests the assumption of variable-centred approaches and hypothesises that, in fact, the population is heterogeneous in respect to the relationships between variables; particularly that different profiles of self-regulation can be identified over time (Collins & Lanza, 2010).

The primary reason for including a person-centred approach in the final study of this thesis is to allow for an examination of self-regulation across the early childhood period, even though the properties of self-regulation measurement change at each wave of data collection. In order to gain insight into the ways in which self-regulation develops from birth to 5 in this study, a person-centred methodology was selected, allowing for the establishment of longitudinal typologies of behaviour. The variable and person-centred approaches are considered complementary, rather than opposing, as each approach provides unique information about the ways in which self-regulation can be understood in early childhood.

3.6.3 Mediation and moderation

The nature of path analyses and longitudinal SEMs give rise to the identification of variables as mediators. A mediator is an explanatory link in the relationship between two other variables (MacKinnon, 2012). In mediation analysis effects are considered direct or indirect. If full mediation occurs, the direct effect between the predictor and outcome is no longer significant when a mediator is introduced. Rather, the predictor influences the mediator which in turn influences the outcome. If partial mediation is present, the direct effect between the predictor and outcome is still present but significantly reduced when a mediator variable is introduced. Within the SEM framework a mediator variable can usually be identified as any variable that has an arrow pointing in to it and an arrow pointing out of it.

In this study, both the path analyses and longitudinal SEMs gave rise to the possibility of mediation effects. Where these became apparent after initial estimation they were tested using the bootstrap procedure currently recommended (MacKinnon, 2012). This procedure involves generating a series of datasets through random sampling. Indirect effects are then estimated from each of the bootstrapped samples. The bootstrap provides a more powerful test in detecting indirect effects because it allows for the non-normal distribution of parameter estimates (MacKinnon, 2012). Because the bootstrap procedure is computationally demanding, bootstrapping was only undertaken as a checking procedure when initial analyses indicated the presence of a mediated or indirect effect.

A moderator is a variable that influences the strength or direction of a relationship between a predictor and an outcome variable (Rose, Grayson, Millstein Coakley, & Franks, 2004). Another term for moderation is interaction effects. These are typically tested by creating new variables that represent the interaction (products) terms of the predictor variables. New SEM techniques also allow moderation to be tested using multiple-group analysis. The more traditional method of creating interaction terms was selected for this study. However, future research plans are to repeat the analysis using multiple-group SEM techniques.

3.6.4 Analytic steps in the development of the measurement and structural models

Recommended SEM steps for primary researchers as described by Kline (2011) were reviewed and adjusted to reflect the nature of the current research as secondary data analysis. These steps will be generally outlined here and the results of each are reported in the following results chapters. This process applies for the CFAs, SEMs and path analyses that were conducted. The analysis steps were: thorough data screening; model specification; estimation of the model with evaluation of fit indices and parameter estimates; and re-specification of the model as required.

Data screening included the examination of included variables in relation to outliers, normality assumptions and multicollinearity issues. General guidelines identified in the literature are that kurtosis scores should have an absolute value no greater than ten and that skewness scores should have an absolute value no greater than three (Kline, 2011). With very few exceptions, the variables included in this study met these criteria. To further ensure the validity of the results and to also account for the ordinal categorical nature of self-regulation indicators, the WLSMV estimator was chosen. This method of estimation provides “weighted least square parameter estimates using a diagonal weight matrix with standard errors and mean- and variance-adjusted chi-square test statistic that use a full weight matrix” (Muthén & Muthén, 1998 - 2012,

p. 533). This estimator has been recommended where analyses use data that are categorical or ordinal in nature (Brown, 2006).

Models were specified based on the research to date and theoretical considerations discussed in Chapter 2, and were further constrained by the variables available in the dataset. *A priori* decisions on how model fit would be evaluated were made following extensive reading of the SEM literature including model fit discussion papers (McDonald & Ho, 2002; Schreiber et al., 2006) and recently published longitudinal developmental research in leading journals.

The chi-square statistic provides a null hypothesis significance test measure of exact fit. That is, it quantifies the predictive power of the hypothesised model in relation to the real-world data to which it is fitted. If the chi-square test is non-significant, (i.e., $p > .05$) then the model is considered a good fit for the data. However, it has been noted that the conditions for this test statistic to meet the precise chi-square distribution will rarely be met in real world research (Bentler, 2007) and that with large sample sizes, it is unlikely that a non-significant chi-square test will be achieved (Byrne, 2012). Therefore, a range of other fit indices have been developed and were used to assess the model fit, along with the other information provided by the model estimation output (Bentler, 2007).

Model fit was considered using the Tucker-Lewis Index (TLI), Comparative Fit Index (CFI), root mean square error of approximation (RMSEA), and weighted root mean residual (WRMR). Both the TLI (Tucker & Lewis, 1973) and the CFI (Bentler, 1990) are incremental fit indices through which improvement of fit of the specified model is compared with a null hypothesis model in which there are no structural relationships between the variables tested. Suggested cut-off criteria of values close to or higher than 0.95 have been suggested for both the TLI and CFI when using continuous data (Hu & Bentler, 1999). More recently, a cut-off value of higher than 0.96 for the CFI with sample sizes over 250 and for categorical data has been recommended (Yu, 2002).

The RMSEA is an absolute fit index which is sensitive to the number of parameters estimated in the model (Steiger, 1998). It has a known distribution that permits the calculation of confidence intervals. Hu and Bentler (1999) have recommended a cut-off value for RMSEA of close to or lower than .06. The WRMR measures the (weighted) average differences between the sample and estimated population variances and covariances.

The WRMR has been proposed as useful when sample statistics are on different scales, such as in the current study, and is also suitable for non-normal data. The recommended cut-off value for WRMR of close to or lower than 1.0 has been found to perform well in CFA models, although using this value makes it more likely that models with trivial misspecification of factor covariance may be rejected (Yu, 2002). WRMR values that were close to 1.0 but at times greater than 1.0 were therefore accepted in the current study.

Re-specification of the models was considered where the baseline model showed poor fit to the data. This was done by examining model estimates and modification indices produced through the initial estimation process. Modification indices were examined to identify parameter constraints which, if freely estimated, would contribute to a significant drop in chi-square, hence, potentially improving overall model fit (Byrne, 2012). These issues were used to guide decisions regarding model re-specification. Correlation residual estimates quantify the extent to which correlations implied by models and observed correlations differ. Model outputs were screened for correlation residuals with absolute values of over .10 as SEM rules of thumb suggest (Kline, 2011).

Once a final model was accepted the estimates were interpreted. The model estimates included the path coefficients and r-squares for the items. R-square values represent the proportion of variance in each dependent variable accounted for by the model. The path coefficients correspond to traditional regression estimates or effect sizes and are shown as arrows in figures. Where the arrow head points to a continuous variable (the dependent variable), the path coefficient refers to a linear regression coefficient. When the arrow head points to a categorical or ordinal variable, the path coefficient refers to a probit regression coefficient.

Standardised coefficients are useful in comparing the relative contribution of each of the variables to the dependent variables and are provided throughout the results chapters. Where covariates are continuous, estimates are standardised in relation to both the independent and dependent variable and provided as StdYX values in Mplus output. These standardised estimates can then be interpreted as the standard deviation change in the dependent variable with a one unit change in the independent variable. Where the covariate is binary (such as for the control variables of gender and history of maternal depression in this study), coefficients were standardised in relation to the dependent variable. Mplus generally provides these as StdY values in output, however, where the WLSMV estimator is selected, as it was in these analyses, these are not provided and must be calculated by hand. The equation for this is the standardised value (Std in Mplus) divided by the standard deviation of the independent variable. Standard deviations for the independent variables were calculated by finding the square root of the variable variances which are provided in Mplus output on the diagonal of the covariance matrix.

3.6.5 Analysis steps for latent profile analysis (LPA)

The analysis steps for LPA are: step-wise estimation of models with increasing numbers of latent profiles; adjudication of fit indices and other information to arrive at the number of profiles which best fit the data; and, interpretation of the profiles and checking of multivariate differences among the profiles (Collins & Lanza, 2010). Estimation of a LPA in Mplus is achieved using the maximum likelihood estimator which iteratively calculates model parameters that are most likely to account for the observed data. A posterior probability of profile membership for each latent profile is then calculated and individuals can be assigned a latent profile for which their posterior probability is highest (Muthén, 2004).

Selection of the optimal number of profiles was based on a range of criteria. Four measures of relative model fit (compared to the same model with one less profile) were used including the Bayesian Information Criterion (BIC; Schwarz, 1978) and the Consistent Akaike's Information Criterion (CAIC; Bozdogan, 1987). For both of these indices, the lowest value indicates the "best" model. Two other measures of relative fit were also selected for use. Both the Lo-Mendell-Rubin (LMR) test (Lo, Mendell & Rubin, 2001) and the bootstrapped likelihood ratio test (BLRT; McLachlan & Peel, 2000) signal the "best" model as the one with the smallest number of profiles that is not significantly improved by the addition of another profile.

Along with these measures of model fit, it is also recommended that researchers carefully consider the profile sizes, the substantive meaning and value of the resulting profiles and the ability of the latent profiles to correctly classify individuals (Collins & Lanza, 2010). In the current study it was decided that a profile resulting in likely membership of fewer than 100 cases (3.5% of the sample) would be limited in its applicability to real world settings and of little utility in ongoing analyses of profile predictors and outcomes. It was recognised that to have practical applicability in terms of identifying children at risk of poorer outcomes, the latent profile variable needed to be able to strongly differentiate children with more problematic self-regulation profiles from those with consistently positive self-regulation profiles. Statistical indicators to be examined were the relative entropy of the model, that is, the extent to which there was a lack of error in classifying individuals into their respective profiles (higher values indicate less error), and the average posterior probabilities of profile membership (on a scale of zero to one with higher scores preferred; Collins & Lanza, 2010).

Once the final number of profiles was decided upon, multivariate checking of the extent to which the profiles differed on the indicator, control and outcome variables was conducted. Chi-square tests were used for covariates that were binary in nature and analyses of variance (ANOVAs) were used for the remaining continuous variables. Path models that examined the relationships between self-regulation profile membership, maternal parenting and mental health and later outcomes were then developed. In these path models, the latent profile membership variable was treated as an ordinal categorical variable with higher scores indicating membership of the more poor regulation profiles. The WLSMV estimator was selected to take account of this ordinal variable.

3.6.6 Missing data

The sample selection procedure outlined in Section 3.4 resulted in a minimal amount of missing data in the final sample. Contemporary missing data techniques require the researcher to establish the extent to which data is missing completely at random (MCAR), missing at random (MAR) or missing not at random (MNAR; Enders, 2010) in order to justify the selected treatment of the missing data. The most likely and favourable scenario in real-world research settings is MAR, where missingness is not a result of the value that would have been provided if it were not missing, but is likely related to other variables or participant characteristics. This section describes the amount and treatment of missing data in each of the variable areas of self-regulation, parenting and behavioural problems.

Across the self-regulation indicator variables (sleep regulation, reactivity and persistence), there were 4 to 36 cases with missing data depending on the item and the wave. At most this represents 1.3% of the total sample and so was considered negligible. Similarly, across the parenting variables, there were 5 to 33 cases with missing data, depending on the item. At most this represents 1.1% of the total sample and so was again considered negligible. Missing data on the maternal depression items was also present for less than 1% of the sample. Tests for the extent to which missingness on these items was a function of other variables in the dataset were not conducted due to the very small amount of missing data present.

A greater extent of missing data was found for the outcome measures taken from Wave 4 of the dataset, as complete Wave 4 data was not a requirement for sample selection. A total of 123 cases within the study sample of 2880 did not have mother-reported behaviour problems or maternal mental health data for Wave 4 due to sample attrition within the longitudinal study. Differences between these 123 cases and the rest of the study sample with complete data were tested and no differences were found on Aboriginal or Torres Strait Island status, main language other than English, child gender, self-regulation indicators or maternal history of depression. However there were differences between those with complete and missing data at Wave 4 in regards to socio-economic disadvantage (SED), with those with missing data having a significantly higher SED score at Wave 1 than those with complete data ($F = 15.4$, $df = 1$, $p = .000$). Given that a relationship between self-regulation indicators and mother-reported behaviour problems at Wave 4 was hypothesised, the lack of relationship between the self-regulation variables and missingness on the outcome measure at Wave 4 was taken as a strong indication that the missing data would be unlikely to be predicted by the actual behaviour problem data if it were available. That is, it is unlikely that parents who had children with significantly higher or lower levels of behaviour problems comprised the participants that did not complete Wave 4 data. Therefore it was reasonable to assume that the data was MAR, that is, unlikely to be missing due to the scores that would have been provided, rather than NMAR (Enders, 2010). The same assumption was made in relation to the missing maternal mental health data because there was no relationship between history of maternal depression and missing maternal mental health data at Wave 4.

A total of 564 cases within the study sample of 2880 did not have teacher-reported behaviour problem data for Wave 4 due partly to sample attrition within the longitudinal study and partly to lower teacher response rates. Differences between these cases and the rest of the study sample with complete data were tested and no differences were found on Aboriginal and Torres Strait Islander status, main language other than English, SED, child age, child gender, or maternal history of depression. It was assumed that the teacher-reported behaviour problem data was at least MAR.

Working on the assumption that all missing data was MAR, a number of approaches to the treatment of missing data were considered. These were the use of maximum likelihood estimators in the estimation of models in Mplus as these estimators are able to handle missing data without imputation; multiple imputation prior to analysis; and, expectation maximisation (EM) imputation prior to analysis. The estimator chosen for the substantive analyses conducted in Mplus for this thesis was largely the WLSMV estimator, selected to accommodate the ordinal categorical nature of many of the variables (with the exception of the final study which used the maximum likelihood estimator). This precluded the use of the maximum likelihood estimator to directly handle missing data. Multiple imputation was considered too computationally burdensome for the large dataset and large number of variables in this study. Therefore EM imputation was completed in the Statistical Package for Social Sciences program (SPSS) prior to the substantive analyses in order to allow a complete dataset to be analysed in the Mplus models. In the case of the single dichotomous item of history of maternal depression, missing cases (less than 1%) were imputed with the most common response of *"no"* (to a history of depression).

3.7 The Four Studies Developed in This Thesis

3.7.1 Study 1: Relationships among sleep, reactivity, and persistence from infancy to 5 years.

The research question for Study 1 is: *What are the relationships among parent-reported sleeping problems, temperamental reactivity and temperamental persistence over the first five years and what do they tell us about early childhood self-regulation?*

This study involves data from Waves 1, 2 and 3. Measures tapping the behavioural, emotional and cognitive domains of self-regulation at each wave are selected for investigation. First, data preparation and screening are conducted. Data preparation includes the examination of descriptive statistics to identify outliers and to examine the skewness and kurtosis of the data.

Data from Waves 1, 2 and 3 are then used in a series of models to explore the measurement properties of the items and the various relationships between the constructs. First, the properties of the measurement models for sleep, emotional and cognitive regulation are examined using parent reports on sleep problems, reactivity and persistence at each of the three waves. Second, the cross-sectional and longitudinal relationships among the variables are explored using longitudinal SEMs.

3.7.2 Study 2: Associations between early childhood self-regulation, maternal mental health and behavioural outcomes for children

The research question for Study 2 is: *How is self-regulation from birth to age 5 associated with maternal mental health across time and children's social, emotional and behavioural outcomes at age 6-7?*

The self-regulation measurement models established in Study 1 are used as the basis for this study. Longitudinal panel SEMs are developed and estimated. These establish the relationships between early childhood self-regulation indicators and social, emotional and behavioural outcomes at 6-7 years. They also investigate the extent to which there is evidence for bidirectional relationships between maternal mental health and children's self-regulation across this period. In this study four longitudinal models are tested: the relationship between early self-regulation indicators and later behaviour problems for children; a child-driven effects model for maternal mental health and self-regulation; a mother-driven effects model for maternal mental health and self-regulation; and, a full model which includes child-driven and mother-driven effects and their relationship to behavioural outcomes.

3.7.3 Study 3: The role of maternal parenting and mental health in the relationship between early childhood self-regulation and later behavioural problems

The research question for Study 3 is: *Is the relationship between children's self-regulation during the third year and child behavioural outcomes in the seventh year moderated or mediated by maternal parenting and mental health measured in the fifth year?*

The purpose of this study is to explore the extent to which aspects of maternal parenting and mental health act as mediators or moderators in the relationship between early self-regulation and later behaviour problems for children. Two types of analyses are undertaken in this study: moderation and mediation. The reason for this is that although various measures of maternal parenting and mental health have been shown to be related to children's self-regulation in a number of ways, clear conclusions about the effect of maternal parenting and mental health in this area of study cannot yet be made. Path models are used to establish evidence related to this research question.

3.7.4 Study 4: Longitudinal profiles of self-regulation across the first five years and their relationship to parenting and behavioural outcomes.

The research question for Study 4 is: *What are the longitudinal profiles of self-regulation in children aged birth to 5 and how are they related to child outcomes and parenting?*

This study uses sleep, reactivity and persistence as indicators in a longitudinal latent profile analysis. The resultant profiles (birth to age 5) are then used in multivariate and path analyses to examine the predictors of profile membership and the social, emotional and behavioural outcomes and maternal parenting behaviours associated with profile membership. Finally, the extent to which maternal parenting and mental health mediate the relationship between early childhood self-regulation profile membership and outcomes is examined.

3.8 Ethical Considerations

The LSAC data set is confidentialised and made available for use by researchers upon application to DSS. The institution at which the candidate is enrolled (Queensland University of Technology, QUT), has an organisational license to the dataset for which an individual student application for access was submitted in regards to the current study. The LSAC dataset has received ethical approval through the AIFS, the body that manages the study; hence the QUT Ethics Advisor advised that the dataset is exempt from ethical review at QUT. National Statement Section 5.1.22 of the University Human Research Ethics Committee (UHREC, p.79) indicates that: “Institutions may choose to exempt from ethical review research that (a) is negligible risk research….; and (b) involves the issue of existing collection of data or records that contain only non-identifiably data about human beings.” The basic documentation required by the UHREC in order to fulfil ethics requirements in this instance where the requirement for a full ethics submission was waived, were submitted and accepted.

3.9 Conclusion

The aim of this program of research is to investigate the patterns of self-regulation development in Australian children from birth to 5 years, and explore the ways in which maternal parenting and mental health interact with children’s self-regulation to produce particular social, emotional and behavioural outcomes for children. The research comprises a secondary data analysis of the Longitudinal Study of Australia Children (LSAC). A subsample of 2880 children participating in the LSAC Birth Cohort were selected as participants on the basis of having a substantial amount of complete data across the first three waves of data collection (birth to 5 years) in relation to the key variables of interest. These data are used to address the four research questions proposed by four studies in turn. A concerted effort to use contemporary statistical approaches including latent variable modelling is taken in designing and conducting the studies. Study 1 uses CFA and longitudinal SEMs to explore the measurement properties and relationships among indicators of behavioural, emotional and cognitive regulation from infancy to 5 years. Study 2 uses the measurement models established in Study 1 in longitudinal panel SEMs to establish the bidirectional relationships between self-regulation and maternal mental health across time, and the effects of early self-regulation on later behavioural outcomes for children. Study 3 examines the extent to which maternal mental health and maternal parenting mediate or moderate the relationship between early self-regulation and later social, emotional and behavioural outcomes. Finally, Study 4 uses LPA to describe the normative developmental profile of self-regulation across early childhood and explores relationships between profile membership, outcomes and maternal parenting.

The methodology designed for this study represents a significant contribution to the growing field of self-regulation research. First, it is the first study that the author is aware of to investigate the utility of using sleep problems and temperament indicators of self-regulation together in the development of longitudinal models of early childhood self-regulation. Second, the participants are a large sample of Australian children. This represents a significant contribution to the Australian evidence base within a field that is dominated by North American and European studies. Third, the study spans the first year of life through to age 7, representing almost the entire period of early childhood which is rare in the existing literature. Finally, the use of contemporary statistical modelling techniques allows for the careful examination of longitudinal models that aim to empirically reflect transactional models of child development. The examination of bidirectional relationships between the parenting environment and child development is a growing field but examples are still relatively rare.

Chapter 1 of this document provided the background to the current study, introduced the proposed research questions, and explained the significance of the study. Chapter 2 used a systematic literature review of research in the field to inform a discussion on the history, context and definition of self-regulation, its theoretical structure, the ways in which it is measured and what is known on the development of self-regulation in the early years of life. The chapter also synthesised current research in relation to self-regulation and its associations with outcomes for children and early parenting before discussing the implications of the extant body of research to the present study. Chapter 2 also presented a conceptual model for the current study.

Chapter 3 has provided design, sampling and measurement details of the LSAC study and has also provided a brief discussion of the advantages and challenges of secondary data analysis. It also documented the sample selection procedure for the current study and described the study sample in relation to socio-demographic details.

The measures selected for use have been detailed and include measures of child sleeping problems, reactivity and persistence, maternal mental health, maternal parenting and children's social, emotional and behavioural problems. This chapter has set out the analytic approach taken in the thesis and documented the steps required in undertaking CFA, path analysis, longitudinal panel SEMs and LPA. Finally, the four studies that make up this program of research were briefly outlined.

Chapters 4 to 7 document the results of each of the four research studies in turn. Each results chapter is set out in a consistent manner. First an introduction to the research question, its background and its significance are provided. Then the variables used and analytic techniques are discussed. The relevant approach to analysis set out in detail here in Chapter 3 is provided in summary form. The results of the analyses are presented, including descriptive statistics, model results and accompanying figures and tables. Finally, a brief discussion concludes each results chapter. Chapter 8 is the final chapter of the thesis and provides an in-depth discussion and conclusion in regards to the program of research as a whole.

CHAPTER 4

STUDY 1: RELATIONSHIPS AMONG SLEEP, REACTIVITY AND PERSISTENCE FROM INFANCY TO 5 YEARS

4.1 Introduction

Study 1 explores the research question: What are the relationships among parent-reported sleeping problems, temperamental reactivity and temperamental persistence over the first five years and what do they tell us about early childhood self-regulation? Developmental models of self-regulation emphasise the inter-relatedness of the behavioural, emotional and cognitive domains of this construct (Kopp, 1982, 1989). While there appears to be a growing movement toward the conceptualisation of self-regulation as a broad construct encompassing a range of hierarchical domains (McClelland et al., 2010), there is limited empirical work that examines the relationships among the various domains right across the early childhood period. Specifically, although very early sleeping difficulties and excessive crying are considered to be signs of early regulatory problems (Schmid et al., 2010), little has been done to empirically link these behaviours with either concurrent or later across-domain self-regulation.

This research addresses this gap by examining the extent to which sleep regulation is associated with indicators of emotional and cognitive regulation in developmental models of self-regulation encompassing the first five years. Such exploration brings a greater understanding of young children's self-regulatory capacity in the early years and informs new models of measurement for early self-regulation. Given that self-regulatory abilities have been found to be a key predictor of success across the lifespan, it is important to develop ways to identify children at risk of poor self-regulation as early as possible. This investigation of the utility of brief maternal reports of sleep regulation, emotional and cognitive regulation in children may lead to the establishment of a group of 'red flag' indicators. These could be used by health and early education practitioners to identify children who are at greater risk of ongoing self-regulatory difficulties in order to provide extra support to these families.

In this chapter the selection of variables representing self-regulation is described. The results of confirmatory factory analyses (CFAs) conducted to test separate measurement models for each of sleep, emotional and cognitive self-regulation at each of Wave 1 (infancy), Wave 2 (2-3 years) and Wave 3 (4-5 years) are then reported. The way in which these constructs are related to each other across the three waves of data collection is then explored using longitudinal panel structural equation models (SEM). Finally, a brief discussion of the results is provided.

4.2 Data and Methods

These analyses are conducted with the sample of 2880 LSAC Birth Cohort participants selected through the selection procedure outlined in Chapter 3. At Wave 1 children were aged from 3 months to 1 year; at Wave 2, children were aged from 2 to 3 years; and at Wave 3, children were aged from 4 to 5 years.

4.2.1 Measures used in the analyses

Variables of interest were selected *a priori* from measures in the parent interviews across three waves of data collection. Relevant scales from the mother - reported temperament data collected at each wave were selected to represent the domains of emotional and cognitive regulation. These scales were drawn from the *Short Temperament Scale for Infants* (Wave 1), *Short Temperament Scale for Toddlers* (Wave 2) and *Short Temperament Scale for Children* (Wave 3; Prior, Sanson, & Oberklaid, 1989).

Reactivity items from temperament scales were selected at each wave to tap emotional regulation. Persistence items were selected at Waves 2 and 3 to tap cognitive regulation. There were no items measuring cognitive regulation at Wave 1 (infancy). Different item sets at each wave reflect the developmental stages of children the measures are designed for. Mothers responded to items on a 6-point scale: 1 = *almost never* to, 6 = *almost always*. For the current study, items were reverse coded where required in order for higher scores to reflect lower reactivity and higher persistence, and therefore potentially higher regulatory skills.

Variables measuring sleep regulation were selected at each wave to tap biobehavioural regulation. Sleep problems were measured at each wave by four items from The Infant Sleep Study (Bayer et al., 2007), each with a yes/no response. Responses were reverse scored in order for higher scores to reflect a greater capacity to regulate sleep, demonstrated through lower levels of sleeping problems.

4.2.2 Approach to the analyses

Descriptive statistics including frequencies and correlations were used to screen variables prior to further analysis. CFAs for the latent variables of sleep regulation, reactivity and persistence were conducted using Mplus Version 7 software at each wave. This was done to examine the extent to which these items worked well together as indices of self-regulation. The longitudinal relationships among the latent variables for sleep regulation, reactivity and persistence were then explored using longitudinal SEM. All variables were treated in the analyses as ordinal categorical as a maximum of six-point response scales were used and so were not considered continuous. The estimator used was the WLSMV estimator, which provides "weighted least square parameter estimates using a diagonal weight matrix with standard errors and mean- and variance-adjusted chi-square test statistic that use a full weight matrix" (Muthén & Muthén, 1998 - 2012, p. 533). This estimator has been recommended where CFA analyses use data that are categorical or ordinal in nature (Brown, 2006).

The extent to which each model fit the data was assessed using the RMSEA, CFI, TLI and WRMR fit indices as described in Chapter 3. A model was assessed as having 'excellent' fit if it met the criteria for all four fit indices, 'good' if it met the criteria for three indices and was close to meeting criteria for the fourth, 'adequate' if it met criteria for two out of the four fit indices and 'poor' if it met only one or none of the criteria across the four indices.

When the hypothesised measurement model at baseline showed poor fit to the data, the model estimates and modification indices were examined and re-specification undertaken as required. The model estimates included the path coefficients and r-squares for the items. The path coefficients in this case represent tobit regression coefficients because the variables were indicated in the model as categorical. These coefficients represent the factor loadings of the indicator variables onto their underlying latent construct. R-square values represent the proportion of variance in each dependent variable accounted for by its related factor. These are shown in italics in the figures below.

Modification indices were examined to identify parameter constraints which, if freely estimated, would contribute to a significant drop in chi-square, hence, potentially improving overall model fit (Byrne, 2012). These issues were used along with current self-regulation theory to guide decisions regarding model re-specification. Any re-specified models were then compared to the baseline model using the DIFFTEST option in Mplus. This option is required to obtain a correct chi-square difference test when the WLSMV estimator is used because the difference in chi-square values for two nested models using this estimator is not distributed as chi-square (Muthén & Muthén, 1998 - 2012). Significant chi-square difference values indicate that the nested model is a significantly better fit than the baseline model.

Due to the innovative nature of this work and the complexity of the developmental phenomenon under investigation, perfectly fitting models were not anticipated. Goffin (2007) and MacCallum (2003) have noted that SEMs that involve complex psychological and developmental phenomena may not meet tests for perfect fit and therefore it cannot be assumed that they contain the whole truth. Rather, such models that describe a close approximation to reality may guide further theoretical and research developments. Model interpretation and the results reported throughout this chapter were undertaken with reference to a range of recent literature pertaining to the topic of SEM and reporting of measurement models (Bentler, 2007; Jackson et al., 2009; Kline, 2011; McDonald & Ho, 2002; Schreiber et al., 2006).

Prior to conducting the analyses presented in this chapter, a different approach to modelling the relationships among the self-regulation constructs was explored. This involved developing measurement models for a second-order factor of broad self-regulation at each time point. At each wave this second-order factor was indicated by first-order factors of sleep regulation, reactivity and persistence. A single item of eating problems was also used at Wave 1. These analyses were useful in order to learn the theory and procedures for conducting CFAs within a SEM framework, but were ultimately of no substantive use in the ongoing development of this program of research. This is because the second-order models did not fit the data well and various estimation problems prevented them from being used longitudinally. The results of these initial CFA analyses are presented in Appendix E in the interest of space in this chapter.

4.3 Results

In Section 4.3.1, the descriptive statistics on the key measures used to screen variables prior to further analysis are presented. CFAs for each self-regulation construct (sleep regulation, reactivity and persistence) at each wave were then estimated and their correlations across time explored and these are presented in Sections 4.3.2, 4.3.3 and 4.3.4. Finally the cross-sectional and longitudinal relationships among sleep, reactivity and persistence were explored through a longitudinal panel SEM and these analyses are presented in Section 4.3.5.

4.3.1 Descriptive statistics

The frequencies for each of the variables selected for these analyses (following missing data imputation as described in Chapter 3) are shown in Table 4.1 (sleep regulation) and Table 4.2 (reactivity and persistence) along with the label assigned for each variable for the purposes of this study.

Table 4.1 *Frequencies for sleep regulation items*

Variable ***Does your child have any of these problems on 4 or more nights a week?***	**Label**	**Wave 1** ***n*** **(%)**	**Label**	**Wave 2** ***n*** **(%)**	**Label**	**Wave 3** ***n*** **(%)**
Yes, difficulty getting off to sleep at night	s1	248 (8.6)	s21	447 (15.5)	s31	248 (9.9)
Yes, not happy to sleep alone	s2	236 (8.2)	s22	514 (17.8)	s32	486 (16.9)
Yes, waking during the night	s3	1223 (42.5)	s23	880 (30.6)	s33	473 (16.4)
Yes, restless sleep	s4	315 (10.9)	s24	248 (8.6)	s34	125 (4.3)

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Table 4.2 *Frequencies for reactivity and persistence items*

Scale	Variable	Label	Almost never	Not often	Variable, usually doesn't	Variable, usually does	Frequently	Almost always
					n (%)			
Reactivity Wave 1	Fretful on waking up and / or going to sleep	r1	65 (2.3)	234 (8.1)	506 (17.6)	793 (27.5)	818 (28.4)	464 (16.1)
	Amuses self for ½ hour or more in cot of playpen	r2	571 (19.8)	817 (28.4)	712 (24.7)	335 (11.6)	280 (9.7)	165 (5.7)
	Continues to cry in spite of several minutes of soothing	r3	26 (.9)	55 (1.9)	106 (3.7)	442 (15.3)	1177 (40.9)	1074 (37.3)
	Cries when left to play alone	r4	45 (1.6)	95 (3.3)	325 (11.3)	823 (28.6)	1031 (35.8)	561 (19.5)
Reactivity Wave 2	Responds to frustration intensely	r21	112 (3.9)	398 (13.8)	756 (26.3)	711 (24.7)	696 (24.2)	207 (7.2)
	Has moody "off" days when he / she is irritable all day	r22	23 (.8)	86 (3)	344 (11.9)	719 (25)	1144 (39.7)	564 (19.6)
	Shows much bodily movement when upset or crying	r23	139 (4.8)	467 (16.2)	695 (24.1)	613 (21.3)	689 (23.9)	277 (9.6)
	Reacts strongly when unable to complete a play activity	r24	58 (2)	231 (8)	571 (19.8)	808 (28.1)	854 (29.7)	358 (12.4)
Persistence Wave 2	Plays continuously for more than 10 minutes at a time with a favourite toy	p21	7 (.2)	70 (2.4)	144 (5)	633 (22)	1353 (47)	673 (23.4)
	Goes back to the same activity after a brief interruption	p22	14 (.5)	92 (3.2)	256 (8.9)	1216 (42.2)	965 (33.5)	337 (11.7)
	Stays with a routine task for 5 minutes or more	p23	48 (1.7)	292 (10.1)	461 (16)	1101 (38.2)	727 (25.2)	251 (8.7)
	Stops to examine objects thoroughly	p24	36 (1.3)	305 (10.6)	491 (17)	1105 (38.4)	767 (26.6)	176 (6.1)
	Practices a new skills for 10 or more minutes	p25	30 (1)	208 (7.2)	393 (13.6)	1222 (42.2)	810 (28.1)	217 (7.5)
Reactivity Wave 3	If wants a toy or sweet while shopping, will easily accept something else	r31	44 (1.5)	226 (7.8)	322 (11.2)	1165 (40.5)	671 (23.3)	452 (15.7)
	When angry about something, it is difficult to sidetrack him / her	r32	200 (6.9)	1043 (36.2)	584 (20.3)	563 (19.5)	384 (13.3)	106 (3.7)
	When shopping together, If I do not buy what child wants, he/she cries / yells	r33	839 (29.1)	924 (32.1)	631 (21.9)	326 (11.3)	117 (4.1)	43 (1.5)
	If upset, it is hard to comfort him/ her	r34	799 (27.7)	1435 (49.8)	330 (11.5)	196 (6.8)	99 (3.4)	21 (0.7)

Scale	Variable	Label	Almost never	Not often	Variable, usually doesn't	Variable, usually does	Frequently	Almost always
Persistence Wave 3	When starts a project works on it without stopping until it is completed	p31	64 (2.2)	259 (9)	358 (12.4)	1123 (39)	703 (24.4)	373 (13)
	Likes to complete on task or activity before going onto the next	p32	62 (2.2)	335 (11.6)	637 (22.1)	1246 (43.3)	456 (15.8)	144 (5)
	Stays with an activity for a long time	p33	40 (1.4)	227 (7.9)	492 (17.1)	1111 (38.6)	758 (26.3)	252 (8.8)
	When a toy or game becomes difficult, quickly turns to another activity	p34	77 (2.7)	511 (17.7)	1000 (34.7)	912 (31.7)	317 (11)	63 (2.2)

All variables were examined for outliers and for signs of non-normality. Scores for kurtosis and skew fell within the recommended ranges for SEM (Kline, 2011) except for one sleep item at Wave 3 (problems with restless sleep), with a skewness score of 4.484 and a kurtosis score of 18.119. Given that the impact of non-normal distribution of data on SEM greatly reduces as sample size increases (Lei & Lomax, 2005), this single item with non-normal distribution was not considered to be an ongoing concern in analyses.

Data were also tested for signs of multicollinearity between variables by examining the correlation tables produced as output by the Mplus analysis software. Bivariate correlations are presented in Tables 4.3, 4.4 and 4.5 for each wave of data respectively. These are taken from the Mplus output using the WLSMV estimator. Tetrachoric correlations are presented for pairs of binary variables. Polychoric correlations are presented for pairs of ordinal categorical variables and the pairs of binary and ordinal categorical variables. Across the tables, the highest correlation was modest at .672, with most bivariate correlations being less than .5. Therefore there was no ongoing concern for multicollinearity. The few correlations that are more than .5 are bolded. There are very few of these suggesting that convergent validity among the items of each scale was relatively low. Nonetheless testing of CFA measurement models was pursued so that further information on the performance of the measures could be gained and a starting point for analyses across this program of work could be established.

Table 4.3 *Wave 1 correlations for reactivity and sleep items*

	r1	r2	r3	r4	s1	s2	s3	s4
r1	1							
r2	.287	1						
r3	.372	.165	1					
r4	.319	.410	.301	1				
s1	.401	.216	.311	.196	1			
s2	.290	.228	.098	.191	**.540**	1		
s3	.289	.182	.171	.154	.382	.335	1	
s4	.255	.182	.196	.110	.463	.390	.458	1

Table 4.4 *Wave 2 correlations for reactivity, persistence, and sleep items*

	r21	r22	r23	r24	p21	p22	p23	p24	p25	s21	s22	s23
r21	1											
r22	.477	1										
r23	**.540**	.42	1									
r24	**.542**	.403	.472	1								
p21	.042	.048	.033	.050	1							
p22	.056	.065	.006	.044	.476	1						
p23	.104	.031	.021	.084	.408	.446	1					
p24	.016	-.007	-.058	-.100	.348	.302	.358	1				
p25	.042	.026	-.003	-.012	.421	.341	.417	.450	1			
s21	.151	.219	.162	.131	.102	.115	.102	.001	.068	1		
s22	.079	.091	.084	.083	.091	.099	.071	.012	-.039	**.509**	1	
s23	.080	.066	.108	.018	.061	.087	.094	.017	.028	.425	.483	1
s24	.093	.199	.133	.081	.088	.085	.052	-.012	-.006	.388	.471	**.557**

Table 4.5 *Wave 3 correlations for reactivity, persistence, and sleep items*

	r31	r32	r33	r34	p31	p32	p33	p34	s31	s32	s33
r31	1										
r32	.282	1									
r33	.552	.370	1								
r34	.298	.475	.382	1							
p31	.230	.113	.125	.103	1						
p32	.231	.091	.160	.053	**.635**	1					
p33	.262	.115	.148	.145	**.672**	**.592**	1				
p34	.145	.151	.184	.198	.432	.374	.402	1			
s31	.159	.127	.202	.158	.101	.043	.099	.106	1		
s32	.225	.065	.191	.128	.114	.091	.121	.110	**.515**	1	
s33	.146	.076	.189	.132	.099	.114	.139	.087	.409	**.559**	1
s34	.148	.131	.142	.207	.053	.090	.088	.101	.465	**.507**	**.571**

Correlations above .5 are shown in **bold.** Significance testing is not available in Mplus.

4.3.2 Measurement models for sleep regulation

The latent variable of sleep regulation was indicated by four items at each of Wave 1 (s1 – s4), Wave 2 (s21 – s24) and Wave 3 (s31 – s34). The Wave 1 and Wave 2 models had 'good' fit to the data and the Wave 3 model had 'excellent' fit. No modifications were made. Model fit indices are presented in Table 4.6, model estimates in Table 4.7 and standardised estimates in Figure 4.1. All items loaded reasonably strongly onto the latent factor of sleep regulation at each wave (β = .581 to .766).

Table 4.6 *Fit indices for the sleep regulation measurement models*

Model	**Chi-square (df)**	***p***	**RMSEA (90% confidence interval)**	**CFI**	**TLI**	**WRMR**
Recommended cut off values		*>.05*	*<.5*	*>.95*	*>.95*	*<1*
Wave 1	15.519 (2)	.000	.048(.028 – .072)	.980	.940	1.028
Wave 2	15.003 (2)	.000	.048 (.027 – .071)	.989	.966	1.015
Wave 3	7.517 (2)	.023	.031 (.010 - .056)	.994	.983	.695

As the sleep items remain the same across waves of data collection, tests for measurement invariance were conducted. These test the extent to which the latent variables and associated items are measuring the same construct across time. These tests failed in this instance. This suggests that mother reports of children's sleeping problems across time are not measuring the same underlying self-regulatory capacity at each time point. This represents a significant limitation of this study. Despite this concern, the longitudinal correlations among the latent variables of sleep regulation were estimated with standardised results presented in Figure 4.1. This was done as a matter of interest. Each of the sleep items were correlated with the identical items at each of the waves. That is, s1 was correlated with s21 and s31 and so on. The model was assessed as having 'excellent' fit to the data. Correlation estimates were relatively high and increased over time (r = .505 between Waves 1 and 2 to r = .692 between Waves 2 and 3).

Table 4.7 *Parameter estimates for the sleep regulation measurement models*

Parameter	**Unstandardised *(se)***	**Standardised *(se)***	***p***
Sleep1 → s1*	1 (.000)	.725 (.040)	.000
Sleep1 → s2	.890 (.080)	.645 (.042)	.000
Sleep1 → s3	.802 (.066)	.581 (.033)	.000
Sleep1 → s4	.945 (.081)	.684 (.040)	.000
Sleep2 → s21	1 (.000)	.632 (.032)	.000
Sleep2 → s22	1.129 (.075)	.714 (.030)	.000
Sleep2 → s23	1.125 (.075)	.711 (.029)	.000
Sleep2 → s24	1.112 (.077)	.703 (.035)	.000
Sleep3 → s31	1 (.000)	.629 (.037)	.000
Sleep3 → s32	1.218 (.089)	.766 (.031)	.000
Sleep3 → s33	1.155 (.083)	.726 (.032)	.000
Sleep3 → s34	1.158 (.091)	.728 (.042)	.000

* → represent regressions

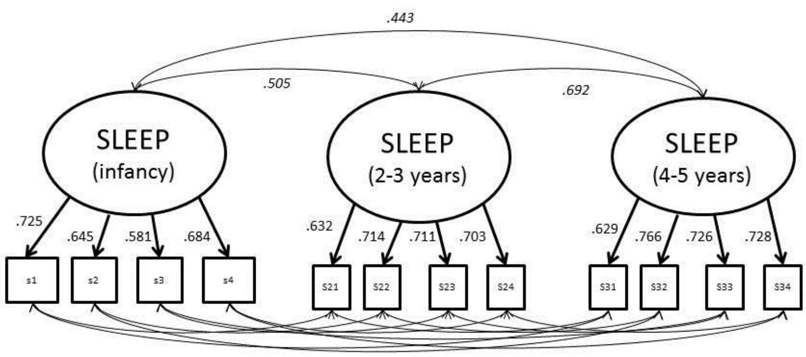

Figure 4.1. Sleep regulation measurement models and longitudinal correlations. All estimates are standardised and significant. Fit statistics for the longitudinal correlations model: x^2 = 88.5, *df* = 39, *p* = .000, CFI = .989, TLI = .982, RMSEA = .021 (CI .015 - .027), WRMR = .913.

4.3.3 Measurement models for reactivity

The latent variable of reactivity, selected to represent emotional regulation, was indicated by four items at each of Wave 1 (r1 – r4), Wave 2 (r21 – r24) and Wave 3 (r31 – r34). Fit indices showed an 'excellent' fit for the measurement model for Wave 2 but not for Waves 1 and Wave 3. The modification indices were then examined to determine the potential sources of misfit.

For Wave 1, it appeared that the error variances between items r2 (*amuses self for 30 minutes or more*) and r4 (*reverse of cries when left alone*) were not well replicated. This correlation was considered to make theoretical sense in that there could be some overlap in the measurement of these items. Children who are able to amuse themselves for 30 minutes or more are less likely to cry when left alone. The correlation of these error terms was then freely estimated in the next model and the DIFFTEST analysis used in Mplus to compare nested models yielded a non-significant chi-square (x^2 = 118.326, df = 1, p = .000), indicating that this modification had significantly improved the model fit.

For Wave 3, the modification indices suggested that the error terms of r32 (*difficult to sidetrack when angry*) and r34 (*difficult to comfort*) were showing significant measurement overlap. This correlation appeared to make theoretical sense as some respondents may consider that comforting a child could include soothing / distracting them when angry or upset. The correlation of these error terms was then freely estimated in the next model and the DIFFTEST analysis used in Mplus to compare nested models yielded a non-significant chi-square (x^2 = 219.005, df = 1, p = .000), indicating that this modification had significantly improved the model fit.

Model fit indices for the final models are presented in Table 4.8, model estimates in Table 4.9 and standardised estimates in Figure 4.2. Final model fit was assessed as 'adequate' for Wave 1 and 'excellent' for Waves 2 and 3.

Table 4.8 *Fit indices for the reactivity measurement models*

Model	**Chi-square (df)**	***p***	**RMSEA (90% confidence interval)**	**CFI**	**TLI**	**WRMR**
Recommended cut off values		*>.05*	*<.5*	*>.95*	*>.95*	*<1*
Wave 1	26.580 (1)	.000	.094 (.065 – .127)	.987	.924	.693
Wave 2	1.043 (2)	.594	.000 (.027 – .031)	1	1	.139
Wave 3	.200 (1)	.655	.000 (.010 - .038)	1	1	.049

Table 4.9 *Parameter estimates for the reactivity measurement models*

Parameter	**Unstandardised *(se)***	**Standardised *(se)***	***p***
React1 → r1*	1 (.000)	.681 (.023)	.000
React1 → r2	.556 (.042)	.379 (.023)	.000
React1 → r3	.800 (.049)	.545 (.022)	.000
React1 → r4	.730 (.046)	.497 (.022)	.000
Covariance r2 with r4	.222 (.019)	.277 (.021)	.000
React2 → r21	1 (.000)	.787 (.011)	.000
React2 → r22	.768 (.021)	.604 (.015)	.000
React2 → r23	.877 (.021)	.690 (.012)	.000
React2 → r24	.970 (.020)	.685 (.013)	.000
React3 → r31	1 (.000)	.652 (.017)	.000
React3 → r32	.668 (.028)	.436 (.018)	.000
React3 → r33	1.228 (.057)	.846 (.019)	.000
React3 → r34	.695 (.030)	.453 (.019)	.000
Covariance r32 with r34	.277 (.016)	.346 (.018)	.000

* → represent regressions

Tests for measurement invariance were not conducted as the survey items changed at each wave. This was necessary within the LSAC dataset in order to reflect the rapidly changing development of children across this period. It does represent a substantial limitation of the current study. It cannot be empirically determined whether or not maternal report on these items is reflective of the same underlying construct of emotional regulation across the early childhood period. Nonetheless, for interest, the longitudinal correlations among the latent variables of reactivity were estimated with standardised results presented in Figure 4.2. The model was assessed as having 'good' fit to the data. Correlation estimates were moderate and increased over time. (r = .298 between Waves 1 and 2 to r = .534 between Waves 2 and 3).

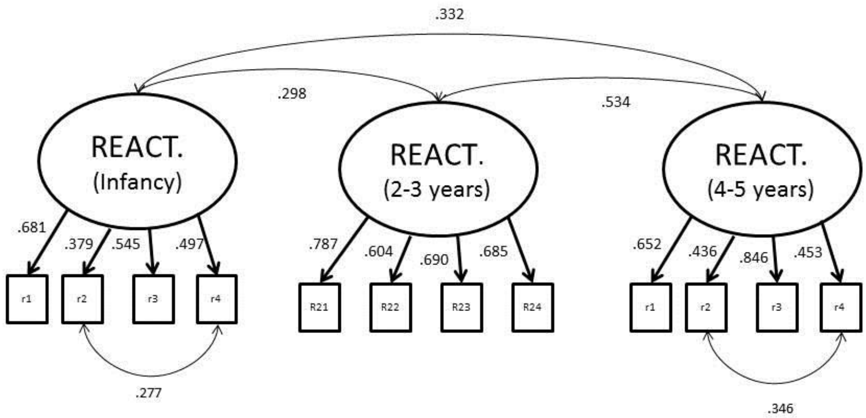

Figure 4.2. Reactivity measurement models and longitudinal correlations. All estimates are standardised and significant. Fit statistics for the longitudinal correlation model: x^2 = 366, *df* = 49, *p* = .000, CFI = .974, TLI = .986, RMSEA = .047 (CI. 043 - .052), WRMR = 1.492.

4.3.4 Measurement models for persistence

The latent variable of persistence, selected to represent cognitive regulation, was indicated by four items at each of Wave 2 (p21 – p24) and Wave 3 (p31 – p34). Temperament items related to cognitive regulation were not available at Wave 1. Although the persistence subscale of the temperament measure in LSAC contained a fifth item, in previous analyses this item was found to perform poorly (see Appendix E) and so was not included here. Fit indices are provided in Table 4.10 below. No modifications were made. Model estimates are provided in Table 4.11 and standardised estimates in Figure 4.3. Model fit was assessed as 'good' for Wave 2 and 'excellent' for Wave 3.

Table 4.10 *Fit indices for the persistence measurement models*

Model	**Chi-square (df)**	***p***	**RMSEA (90% confidence interval)**	**CFI**	**TLI**	**WRMR**
Recommended cut off values		*>.05*	*<.5*	*>.95*	*>.95*	*<1*
Wave 2	52.673 (2)	.000	.094 (.073 – .116)	.987	.960	.980
Wave 3	.329 (2)	.849	.000 (.010 - .020)	1	1	.066

Table 4.11 *Parameter estimates for the persistence measurement models*

Parameter	**Unstandardised *(se)***	**Standardised *(se)***	***p***
Persist2 → p21*	1 (.000)	.687 (.015)	.000
Persist2 → p22	.958 (.031)	.658 (.016)	.000
Persist2→ p23	.960 (.029)	.660 (.015)	.000
Persist2 → p25	.862 (.030)	.592 (.016)	.000
Persist3 → p31	1 (.000)	.850 (.008)	.000
Persist3 → p32	.878 (.014)	.746 (.010)	.000
Persist3→ p33	.932 (.015)	.792 (.009)	.000
Persist3 → p35	.596 (.017)	.506 (.014)	.000

* → represent regressions

As for reactivity discussed above, tests for measurement invariance were not conducted as the survey items changed at each wave to accommodate the developmental stages of children participating in LSAC. Again, this represents a limitation in that it cannot be empirically determined whether or not maternal report on these items is reflective of the same underlying construct of cognitive regulation across the early childhood period. Again for interest, the correlation of the latent variable of persistence at Wave 2 and persistence at Wave 3 was estimated with standardised results presented in Figure 4.2. The model was an 'excellent' fit to the data. The correlation estimate was moderate at r = .438.

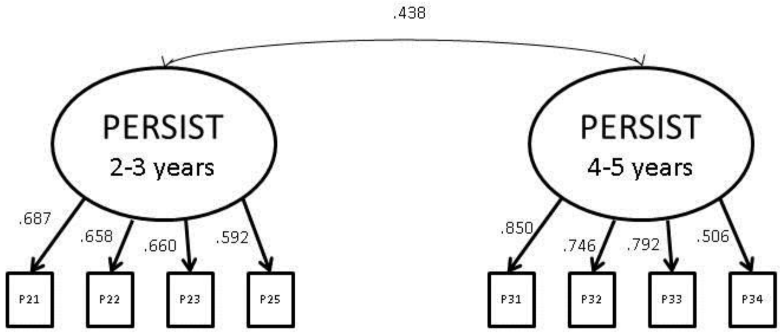

Figure 4.3. Persistence measurement models and longitudinal correlations. All estimates are standardised and significant. Fit statistics for the longitudinal correlation model: x^2 = 88.5, *df* = 39, *p* = .000, CFI = .989, TLI = .982, RMSEA = .021 (CI .032 - .047), WRMR = .913.

4.3.5 Cross-sectional and longitudinal relationships: Sleep, reactivity and persistence

A series of models were estimated in order to explore the cross-sectional and longitudinal relationships among sleep regulation, reactivity and persistence from infancy to 5 years. The first model estimated the cross-sectional correlations among the latent variables as well as the auto-regressive paths. That is, sleep regulation and reactivity at Wave 1 were allowed to correlate and so on, and sleep regulation at Wave 3 was predicted by sleep regulation at Wave 2 which was predicted by sleep regulation at Wave 1 and so on (auto-regressive paths). This model showed 'adequate' fit to the data (x^2 = 1871.671, df = 436, *p* = .000, RMSEA = .034, CFI = .952, TLI = .946, WRMR = 1.800).

The next model tested the hypotheses that in addition to the auto-regressive paths included above, there would be longitudinal cross-construct relationships among sleep, reactivity and persistence. It was anticipated that sleep regulation might predict later reactivity and cognitive regulation given that recent findings suggest a role for sleep in the development of higher order regulatory processes (Bernier et al., 2013). On the other hand, earlier reactivity might also predict later sleep regulation as children who are typically more difficult to soothe and less able to calm themselves might also present with troubles regulating their own sleep at night. In the absence of any strong theory and empirical evidence on the specific direction of expected relationships among the latent variables, an exploratory approach was taken by estimating a model in which all potential cross-lagged paths from one wave of data to the next wave were estimated. That is, sleep regulation in infancy predicted reactivity and persistence two years later and so on, reactivity at infancy predicted sleep and persistence two years later and so on. The initial model estimated is shown in Figure 4.4. This was followed by stepwise trimming of non-significant paths. This approach to model development is one option when work is reasonably new and unique and there is limited evidence upon which to form hypotheses prior to model estimation (Little, 2013).

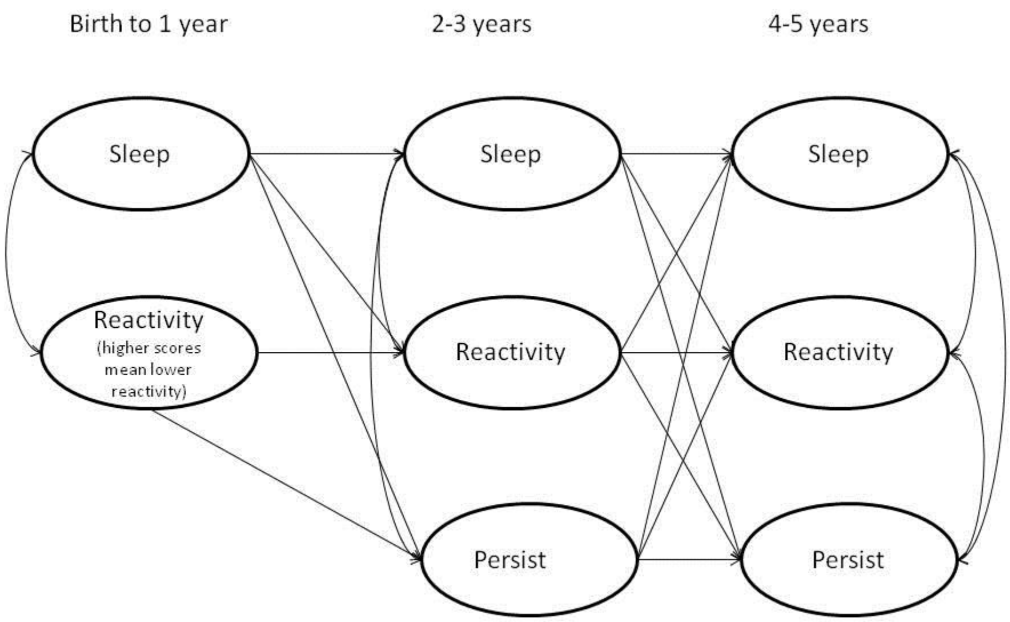

Figure 4.4. Initial longitudinal model for aspects of self-regulation from infancy to 4-5 years.

The initial model was a ‘good’ fit to the data (x^2 = 1426.87, df = 428, p = .000, RMSEA = .028, CFI = .967; TLI = .964, RMSEA = .028; WRMR = 1.497). Non-significant paths were trimmed in a step-wise fashion in the following order followed by model re-estimation after each step: Sleep2 → Persist3; Sleep1 →React2; React1 → Sleep2; Persist2 → Sleep3; React2 → Sleep3. None of these models proved to be a significantly better fitting model than the initial model as shown by significant chi-squares in the DIFFTEST analysis used to compare nested models. The final trimmed model was retained and used as the basis for future analyses across the thesis. This is because this provided a more parsimonious approach to future modelling, preserving power and reducing the computational burden in the models presented in the next chapter which pursues additional substantive relationships of interest (Little, 2013).

The final model estimates are given in Table 4.12 and the standardised estimates are shown in Figure 4.5. The relationships of the indicator variables to their corresponding latent variables are not repeated in the table or figure in the interest of space and clarity for the reader. Cross-sectional correlations among the latent variables were relatively high during infancy (r = .641 for sleep and reactivity), but were low at other waves. All were significant with the exception of the correlation between reactivity and persistence at Wave 2. The model showed moderate to high levels of homotypic continuity with maternal report of children’s sleep regulation particularly stable from 2-3 years (see the auto-regressive paths). Heterotypic stability among the constructs was less evident with many of the cross-lagged paths trimmed due to non-significance. Reactivity during infancy was a moderately strong (β = .424) predictor of persistence at 2-3 years, and this pattern continued with reactivity at 2-3 years predicting persistence again two years later (β = .165). Persistence at 2-3 years also predicted reactivity at 4-5 years (β = .233). Sleep regulation at age 2-3 years predicted reactivity at age 4-5 years (β = .142), but sleep regulation in infancy was not predictive of reactivity two years later.

Table 4.12 *Parameter estimates for the longitudinal model examining relationships amongst sleep regulation, reactivity and persistence*

Parameter	**Unstandardised *(se)***	**Standardised *(se)***	***p***
Auto-regressive paths			
Sleep1 → Sleep2	.461 (.040)	.528 (.033)	.000
Sleep2 → Sleep3	.694 (.052)	.729 (.031)	.000
React1 → React2	.364 (.033)	.307 (.025)	.000
React2 → React3	.427 (.023)	.489 (.022)	.000
Persist2 → Persist3	.519 (.027)	.427 (.019)	.000
Cross-sectional correlations			
Sleep1 with React1	.321 (.021)	.627 (.031)	.000
Sleep2 with React2	.075 (.016)	.175 (.035)	.000
Sleep2 with Persist2	.062 (.015)	.165 (.039)	.000
React2 with Persist2	-.003 (.013)	-.007 (.029)	.812
Sleep3 with React3	.055 (.014)	.232 (.054)	.000
Sleep3 with Persist3	.061 (.016)	.185 (.046)	.000
React3 with Persist3	.069 (.011)	.179 (.027)	.000
Cross-lagged paths			
Sleep1 → Persist2	-.189 (.052)	-.222 (.058)	.000
React1 → Persist2	.448 (.060)	.424 (.053)	.000
Sleep2 → React3	.136 (.031)	.142 (.031)	.000
React2 → Persist3	.178 (.023)	.165 (.021)	.000
Persist2 → React3	.229 (.023)	.233 (.022)	.000

* → represent regressions

All results must be interpreted while noting the substantial limitation related to measurement non-invariance. It appears that these items may be measuring different constructs across time and so the results are only indicative of maternal perceptions on these items at each time point. The models are considered to be robust despite these measurement limitations and therefore the resulting estimates can be considered conservative in nature. A particular strength lies in the fact that the model controlled for prior levels of each self-regulation construct. This allows the results to be interpreted in light of *changes* in sleep, emotional and cognitive regulation over time (issues of measurement invariance not withstanding). Specifically, sleep regulation at 2-3 years contributed to *improved* emotional regulation (reactivity) at 4-5 years over and above the continuity effects for emotional regulation. Similarly, emotional regulation at 2-3 years contributed to *improved* persistence two years later even when prior levels of persistence were controlled for.

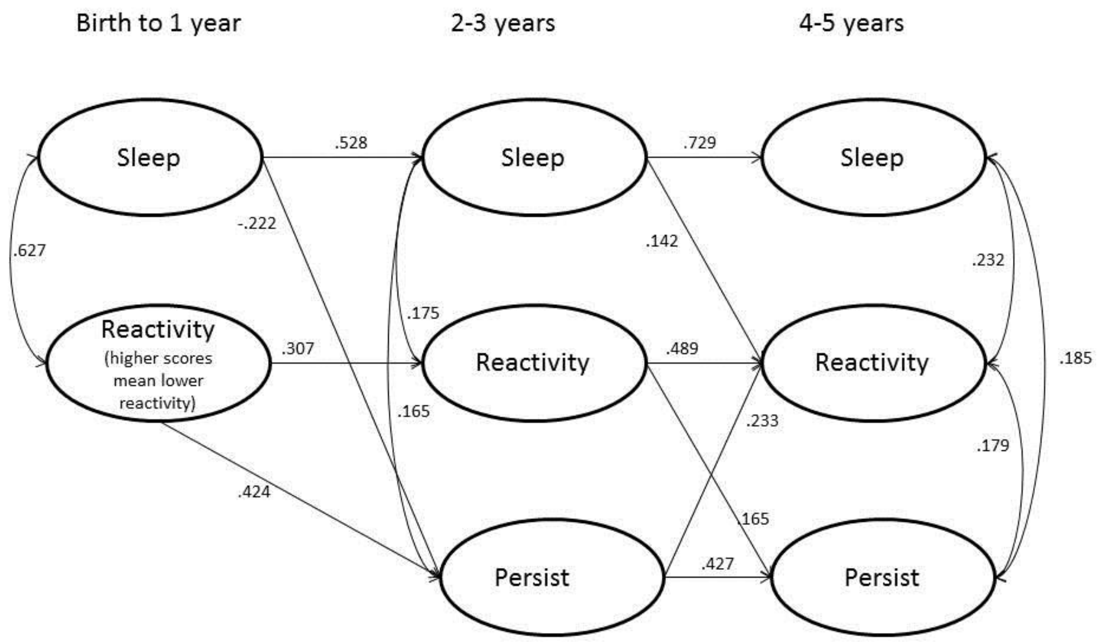

Figure 4.5. Final longitudinal model for self-regulation from infancy to 4-5 years. All estimates are standardised. Fit statistics: x^2 = 1387.7, *df* = 433, *p* = .000, CFI = .968, TLI = .964, RMSEA = .028 (CI .026 - .029), WRMR = 1.497.

4.4 Discussion

The analyses reported in this chapter were conducted to explore the research question: What are the relationships among parent-reported sleeping problems, temperamental reactivity and temperamental persistence over the first five years and what do they tell us about early childhood self-regulation? Indicator variables from the LSAC temperament measures and sleep problem items were used to construct latent variable measurement models to be used as indicators of self-regulatory capacity during infancy (Wave 1), at 2-3 years (Wave 2), and 4-5 years of age (Wave 3). Model fit indices suggested that the models fit the data reasonably well although some modification was required at times. The measurement models for sleep regulation at Wave 3, reactivity at Wave 2 and Wave 3, and persistence at Wave 3 were particularly strong models.

The way in which sleep regulation was measured in the current study differs from the way others using the same LSAC dataset have identified children with sleep problems. In the current study four items asked about consistent night-waking, trouble falling asleep, not being happy to sleep alone and restless sleep. Prior studies on sleep problems in LSAC participants have tended to use a single item which asks parents to identify whether they consider their child to have a sleep problem and to what extent (Quach et al., 2013). While this is a useful measure of the extent to which these parents are likely to experience a negative impact on their own functioning and the extent to which they will pursue support through services (Quach et al., 2013), it does not necessarily measure children's capacity to regulate their own sleep. Some parents may be quite happy to continue to provide sleep regulation support throughout the early years and therefore do not consider a child's inability to fall asleep on their own or resettle themself during the night as a problem per se. In Quach and colleagues' studies, these parents might have reported that their child had no or only mild parent *perceived* sleep problems. However, in the current study they may have identified their children as having a number of sleep problems such as waking at night and being unable to fall asleep on their own. The extent to which these two approaches to measuring sleep problems produce different results in light of the emerging role of sleep in overall self-regulation, should be explored in future studies.

While previous studies have examined the correlations among sleep regulation and temperament during infancy (Hayes et al., 2011), and the predictive power of early sleep problems in relation to later self-regulation (Bernier et al., 2013), this study has been the first to combine mother-reported sleep regulation and temperament in developmental models of self-regulation spanning infancy to age 5. This was done with a large dataset of Australian children, providing an important exploration of maternal perceptions of children's self-regulation across early childhood.

There are a number of interesting interpretations that arise from examination of the final longitudinal model presented in this chapter. First, the auto-regressive paths yielded results that would be expected given developmental theory and previous research. Homotypic stability in these self-regulation indicators was moderate but increased over the course of the first five years (Putnam et al., 2006; Sanson et al., 2009). Higher degrees of stability would be expected from 6 years of age and should be tested in future research. Within-time cross-construct correlations were relatively low, with the exception of sleep regulation and reactivity during infancy (r = .641). This reflects other research findings which indicate infant sleep regulation to be correlated with more positive temperament typologies (Spruyt et al., 2008). The remaining low within-time correlations in this study appear to reflect an increasing relative independence of sleep regulation and temperamental indicators of self-regulation from the age of 2 years.

Other studies have found an ongoing association between temperamental aspects of self-regulation and sleep regulation from early childhood (El Sheikh & Buckhalt, 2005) through to adolescence (Moore, Slane, Mindell, Burt, & Klump, 2011). It may be that in the current study, ongoing problems with sleep regulation from 2-3 years are increasingly a reflection of the parenting environment including maladaptive responses to initial infant sleep problems. Ongoing sleep problems may also be indicative of parenting practices (Bordeleau, Bernier & Carrier, 2012) or issues in parental psychosocial functioning (Bernier, Belanger, Bordeleau, & Carrier, 2012). Thus while only poorly correlated with other child temperament measures, parent-reported sleep regulation problems might be highly correlated with parenting aspects during this time period and further research should investigate this hypothesis. Sleep regulation measures that do not involve only parent report might also address some of these issues.

Regardless of the source of the decreasing within-time, cross-construct correlations, sleep problems across the first five years are still an important consideration in understanding overall self-regulation and general development for children (O'Callaghan et al., 2010; Quach, Hiscock & Wake, 2012; Schimd, Schreier, Meyer & Wolke, 2010). This is particularly so in light of the effect of sleep problems on later reactivity or emotional regulation in children, as indicated by the final model presented in this study.

Second, the cross-lagged structural model provided some evidence for heterotypic continuity across the first five years. Reactivity consistently predicted persistence two years later, despite the fact that cross-sectional correlations between reactivity and persistence were either non-significant (at 2-3 years) or very low (4-5 years). Sleep was highly correlated with reactivity during infancy and predicted reactivity two years later, from the age of 2-3 years. This pattern seems to suggest a developmental cascade whereby poorer sleep regulation is related to poorer emotional regulation (signalled by higher emotional reactivity) which is in turn related to poorer levels of persistence. Further waves of data using similar mother-report measures could test this theory.

Finally, sleep regulation during infancy predicted persistence two years later but in an unexpected direction. Higher sleep regulation scores in infancy were associated with lower persistence scores at 2-3 years of age (β = -.222). This is a counter-intuitive finding that might represent a spurious statistical result. An alternative explanation relates to the temperament typologies defined by Thomas and Chess (1977) and the influence that 'slow-to-warm-up' children might represent within these analyses. The full explanation for this alternative interpretation is provided in Appendix F in the interest of space in this chapter.

There are three important limitations related to measurement in this study that need to be considered. The first is that the measurement models for sleep, reactivity and persistence were not always a perfect fit for the data. This lack of fit was therefore carried through to the longitudinal panel model. While some statisticians would say that perfect statistical fit would not be expected with this large sample size and in the 'real world' where models will only ever be an approximation of the truth (Bentler, 2007), others would say that this is simply symptomatic of inadequate measures and that the models should be rejected outright (Hayduk, Cummings, Boadu, Pazderka-Robinson, & Boulianne, 2007). Given that contemporary research in the self-regulation field tends to include measures of fit similar in magnitude to the ones presented throughout this thesis, it was decided to accept the ‘real world’ view and continue to develop the substantive models using the latent variable measurement models. Lack of fit in the measurement models was likely to be partially due to the reduced item sets used in LSAC. This issue should be a consideration of future research designs, particularly as large longitudinal studies become more popular.

The second measurement limitation relates to longitudinal measurement invariance. As is necessary in many longitudinal studies, the items included in each scale, and the constructs measured at each data collection point were differentially selected in recognition of the early childhood period of rapid development, and the necessity for measures to be age-appropriate at each time-point. The approach of modelling latent variables and their associated measurement models presented here represents contemporary statistical practice. A different approach would have been to use manifest variables (composite scores) to consider growth across time.

This alternate approach of creating composite scores was considered as part of the current research. The most robust methodology for doing so is to create weighted scores for each construct based on the item loadings onto their factor (Zubrick et al., 2013). In this study, the software and estimator chosen for the analyses did not allow for the estimation of the parameters required to create these aggregate scores. The WLSMV estimator was selected for its superior ability to adjust for ordinal categorical and non-normal data. While this was considered an appropriate selection given the recommendations in the literature, it represented a compromise in terms of the parameter estimates available and the preclusion of creating weighted composite scores. Future analyses with the LSAC data will benefit from ongoing careful consideration of the benefits and pitfalls of various methods of model estimation and statistical representation of measures.

Both alternatives to measuring constructs in analyses represent different strengths and weaknesses. The modelling of latent variables compromises statistical measurement invariance and restricts the statistical approaches that can be used, but does allow for the modelling of measurement error across time. The use of composite scores rejects measurement invariance as a consideration and does not model measurement error across time, but does broaden the options for modelling growth. Thus, neither approach appears to be more accurate or favourable than the other. Researchers should consider these issues carefully in designing both measures and analysis plans for future studies. Future work might also aim to address the issue of measurement invariance by designing measures that can be used longitudinally and testing the properties of such.

The third limitation in regards to measurement in this study concerns shared method variance. Using parent-report measures only is often cited as a limitation in various studies (Blandon, Calkins & Keane, 2010; Pesonen et al., 2008). This is due to the fact that issues of single-rater bias may be introduced, and that the objectivity of parents' observations of their child may come into question. Some researchers have found correlations between maternal report of child temperament and self-regulation with laboratory measures to be non-significant (Seifer et al., 2004; White et al., 2011), suggesting that either there is significant bias and measurement error present in maternal report, or that the parental-report and laboratory measures are in fact tapping different aspects of self-regulation, as suggested by White and colleagues (2011). Other researchers have found parental perception to be more highly predictive of later outcomes than direct testing (e.g., Pauli-Pott et al., 2003). A multi-method multi-informant approach would have alleviated these concerns and should be pursued in future work.

4.5 Conclusion

The analyses presented in this chapter explored measurement models for sets of items related to young children's self-regulation capacities from birth to 5 years using data from LSAC Waves 1 to 3 for the Birth Cohort. Latent variables of sleep regulation, reactivity and persistence tapped biobehavioural, emotional and cognitive regulation respectively. The measurement models fit the data adequately although not perfectly in every instance. Further, the relationships among these self-regulation constructs within and across time were explored.

This study contributes to an understanding of self-regulation during infancy and early childhood in a number of ways. First, it addresses the marked disconnect in the literature between infant sleeping, crying, and eating patterns and other temperamental self-regulation measures. Only sleeping (not crying or eating) was available with adequate longitudinal measurement in LSAC to be considered here. Measures for the behavioural, emotional and cognitive domains of self-regulation are well established for children from the age of approximately 18 months. Representing each domain during infancy has proved difficult. Although population health researchers investigate child sleep problems and find them to predict the same kinds of poor outcomes as self-regulation problems (Schmid et al., 2010; Wolke et al., 2009), sleep regulation measures and their relationship to other self-regulation areas has not been well explored across the early childhood period. The findings from this study suggest that sleep may play a key role in children's self-regulation development in the emotional and cognitive domains and thus addressing sleep problems early in life could be highly beneficial.

This study also contributes to the applicability of self-regulation research into real-world settings by using only brief mother-report measures. There is growing evidence that early intervention and preventative practitioners should consider biological or child temperamental characteristics, and early indicators of regulatory problems, as indicative of 'at risk' target groups. Reasons for this include that early sleeping, feeding, and crying problems have been linked with later social and behavioural problems (Schmid et al., 2010). Better regulatory capacity across early childhood has been established as a protective factor (Ramani et al., 2010) and poorer regulation as a risk factor (Kim & Deater-Deckard, 2011; Olson et al., 2011) in relation to social, emotional, and behavioural outcomes for children. If children's early regulatory capacity is to be considered as a risk factor worthy of identification and intervention, practical and easily obtained indicators are required for use by parents and practitioners in the field. While laboratory testing and data collection on the physiological and neurological markers of self-regulation greatly extend our understanding of the processes involved, they are too time consuming and costly to be used as population level screeners. The measurement models tested in this study provide the basis for the development of a group of 'red flags' that may be used by practitioners to identify children and families at the greatest risk of poor self-regulation, and in turn, poorer outcomes. This group can then be targeted by early intervention and prevention efforts.

Finally, these analyses provide the basis for the program of research presented across this thesis. The findings highlight a number of substantial limitations in terms of the measurement of self-regulation within the LSAC dataset. Given that there are no other recent Australian studies that document developmental pathways of self-regulation in children, and the LSAC dataset presents a unique opportunity to do so, it is still considered worthwhile to pursue this line of inquiry. Thus, the following three studies take different approaches to addressing the measurement limitations that were made apparent in this chapter. Each approach represents a unique set of strengths and limitations. In Study 2, the final longitudinal panel model presented in this chapter is used as the basis from which to explore the predictive validity of early childhood self-regulation in regards to early school behavioural problems and maternal mental health. Teacher report of children's behaviour problems is used as an outcome measure in order to address concerns of shared method variance. In addition, the bidirectional relationships between maternal mental health and children's self-regulation over time are investigated in Study 2.

Study 3 uses only the self-regulation indicators at Wave 2 as predictors in models that examine the role that maternal parenting plays in the path between early self-regulation and later school problems. This ameliorates concerns regarding longitudinal measurement invariance. Finally, Study 4 uses composite scores, rather than latent variables, for sleep regulation, reactivity and persistence to determine the normative developmental path for self-regulation development in Australian children. The benefits of this approach are discussed further in Chapter 7.

CHAPTER 5

STUDY 2: ASSOCIATIONS BETWEEN EARLY CHILDHOOD SELF-REGULATION, MATERNAL MENTAL HEALTH AND BEHAVIOURAL OUTCOMES FOR CHILDREN

5.1 Introduction

Study 2 explores the research question: How is self-regulation from birth to age 5 associated with maternal mental health across time, and children's social, emotional and behavioural outcomes at age 6-7? A large body of recent research has established the role that early self-regulation skills play in positive outcomes for young children. This research has rarely included data from across the whole early childhood period. In particular, longitudinal studies that include measurements taken in the first year of life are rare. In addition, the bulk of evidence to date has been produced by North American and European studies. This study makes a significant contribution to a greater understanding of the ways in which particular aspects of self-regulation, at particular time points across early childhood, contribute to positive outcomes for Australian children. By building on the measurement models established in the prior study, the relative contributions of sleep, emotional and cognitive regulation are explored adding an additional level of breadth to prior studies which focus on only one self-regulation component and rarely include sleep with other self-regulation indices.

The importance of the parenting environment in supporting positive child development, particularly in the early years, is widely established. Despite the fact that transactional models of child development emphasise the necessity for researchers to consider both mother- and child-driven effects within the mother-child system, the large majority of research still focuses on mother-driven effects. Emergent findings document the bidirectional effects between maternal mental health and children's behaviour problems from the age of 3 years (Bagner et al., 2013; Neece, Green, & Baker, 2012). Findings such as these and growing research interest in both self-regulation and the testing of transactional models of child development suggest an important gap in the current knowledge base. To what extent is there evidence for both mother- and child-driven effects between maternal mental health and children's self-regulatory capacity across the early years? This question has not yet been addressed by the empirical studies found to date, and so this study represents a significant and unique contribution in this area.

The findings of this study have substantial implications for policy and practice. If more is known about the ways in which particular components of self-regulation, at particular times during early childhood, contribute to positive outcome pathways for Australian children then more targeted supports can be designed. Evidence that carefully explicates the ways in which maternal mental health and children's self-regulation skills interact across this important developmental period will lead to a greater understanding of which aspects supports should aim to address at which time. Greater specificity in the ways that interventions and early education programs are targeted to support children and families will lead to increased effectiveness and better use of limited resources.

In this study, a series of longitudinal panel structural equation models (SEMs) are developed to explore the relationships between early childhood self-regulation and maternal mental health from birth to 5 years, and social, emotional and behavioural problems in children at 6-7 years of age. Study 1developed measurement models for early childhood sleep regulation (biobehavioural regulation), reactivity (emotional regulation), and persistence (cognitive regulation). The final model presented in Chapter 4 documented the longitudinal relationships among these aspects of self-regulation. Study 2 builds on Study 1 by using this model as the basis for the analyses presented in this chapter.

This chapter documents the variables selected for use and describes the SEM approach to analysis. Descriptive statistics and then the results for each of the four models estimated are presented. The first model examines the direct effects of early self-regulation on children's social, emotional and behavioural problems at 6-7 years. The second and third models examine the longitudinal child- and mother-driven effects respectively in relation to children's self-regulation and maternal mental health. The final analyses presented in this chapter combines the three previous analyses to create an overall picture of the extent to which early self-regulation and maternal mental health interact over time to predict behavioural outcomes for children and ongoing maternal mental health.

5.2 Data and Methods

These analyses are conducted with the same sample of 2880 LSAC Birth Cohort participants selected through the selection procedure outlined in Chapter 3 and used in Study 1. The analyses in this chapter build on the longitudinal model presented at the end of Chapter 4 which included sleep regulation, reactivity and persistence measured at three time points from infancy to 4-5 years. In this chapter the relationships between these self-regulation indices, maternal mental health (at each wave) and children's behavioural outcomes (at Wave 4, 6-7 years) are explored while controlling for key socio-demographic characteristics.

5.2.1 Measures used in the analyses

The self-regulation indices for sleep regulation, reactivity, and persistence developed in Chapter 4 that tapped biobehavioural, emotional and cognitive regulation, respectively, are used in the analyses presented in this chapter. These variables are not re-described in this section. Maternal mental health is also introduced into the analyses as a key construct used across this program of research to explore its associations with children's self-regulation and child outcomes. Social, emotional and behavioural problems in children at 6-7 years is the key outcome measure. It is used in two forms as a mother-report measure and as a teacher-report measure. This was done to add methodological strength to the analyses and to address issues of shared-method variance. Support for the predictive validity of mother-reported child regulation in relation to teacher-reported behaviour problems *as well as* mother-reported problems would present a particularly important finding that would alleviate some of the concern that single-rater bias influenced results.

Additionally, a number of control variables were incorporated in the models. These are child gender, socio-economic disadvantage (SED) and maternal history of depression. These were selected for consistent use across this program of study and were described in detail in Chapter 3. Control variables are included in order to partial out the effect of particular characteristics known to substantially contribute to developmental variance among children. Including the effects of these in the models allows for greater confidence that the results related to self-regulation and behavioural outcomes provide information specific to these variables, over and above the contribution of child gender, family SED and maternal depression.

Maternal mental health (MMH)

Maternal mental health was measured by the *Kessler K6* (Furukawa et al., 2003) at each wave of data collection. This measure is designed to detect psychological symptoms and has been widely used in Australian and international population studies (Furukawa et al., 2003). The K6 consists of six items that ask about the respondents feelings over the past four-week period. Items are answered on a five-point scale ranging from 1 = *all of the time* to 5 = *none of the time*. An overall score is calculated by summing and averaging the total score resulting in a score ranging from zero to four. Higher scores indicate the presence of more symptoms. The current study uses four waves of maternal mental health data (Waves 1 to 4).

Outcome measure

Children's social, emotional and behavioural problems were measured by the Total Problems Score of the *Strengths and Difficulties Questionnaire (SDQ)* when children were 6-7 years old. The scale was completed in LSAC by Parent 1 (restricted to mothers in this study; SDQm) during the interview and also by teachers (SDQt). Informants rate how true/typical each statement is of the child's behaviour. Items are answered on a 3-point scale where 1 is *not true*, 2 is *somewhat true* and 3 is *certainly true*. Scores from four problem behaviour subscales are summed to provide the Total Problems Score ranging from 0 to 40 with higher scores representing a higher degree of problems. The SDQ has received extensive psychometric evaluation, revealing strong reliability and validity (Goodman, 2001; Hawes & Dadds, 2004; Holtmann et al., 2011).

Control variables

Child gender was selected given the previously documented differences between boys and girls in relation to self-regulation (Gagne & Goldsmith, 2011; Sanders et al., 2009; Schmidt et al., 2010). Females were coded as zero and males as one.

Socio-economic disadvantage (SED) at Wave 1 was selected due to the previously documented associations between socio-economic status and children's self-regulation development (Degnan et al., 2008; Graziano et al., 2010; Hill et al., 2006).

Higher SED scores indicate lower levels of family income, parental education and occupational status, and therefore higher relative disadvantage.

History of maternal depression was selected as a control variable due to the large body of literature linking maternal depression with child outcomes (Goodman et al., 2011). The measure chosen was a single item which asked the mother at Wave 1, "Have you ever had two or more years in your life when you felt depressed or sad most days, even if you felt okay sometimes?" At Wave 1, this item captured those mothers who had a significant history of depression prior to conception and birth of the study child, eliminating some of the chance that depression related mostly to parenting (e.g., postnatal depression) would be captured.

5.2.2 Approach to the analyses

The analytic technique used is longitudinal structural equation modelling (SEM). This allows measurement models for the latent variables of sleep regulation, reactivity and persistence (from Study 1) to be estimated simultaneously with the regression equations that explain the relationship between these and the outcome variables. It also provides a useful graphical representation of the set of algebraic relationships (regressions) among variables, allows the examination of direct and indirect effects, and indicates which predictors have stronger or weaker relationships with the dependent variables (Little, 2013).

The presence of indirect effects relates to the concept of mediation. A mediator variable is the variable or mechanism by which a predictor influences the outcome variable (Rose et al., 2004). In this study, where initial results from model estimation indicated the presence of mediated effects, these were further tested for significance using the bootstrap procedure for indirect effects available in Mplus and recommended by MacKinnon (2012). The bootstrap procedure was detailed in Chapter 3.

Each arrow in the figures and results tables below represents a regression. Where the arrow head is pointing to a continuous variable (the dependent variable) as in the following analyses, the path coefficient refers to a linear regression coefficient. Standardised coefficients are useful in comparing the relative contribution of each of the variables to the dependent variables and are reported in the figures and tables below. Where covariates are continuous, estimates are standardised in relation to both the independent and dependent variable and are provided as StdYX values in Mplus output. Where the covariate is binary (such as for the control variables of gender and history of maternal depression), coefficients have been standardised in relation to the dependent variable.

5.3 Results

In this section descriptive statistics and results from data screening are first presented. The results of each of the four models estimated are then provided in turn: prediction of behaviour problems at 6-7 years from early childhood self-regulation indices; child-driven effects in relation to self-regulation and maternal mental health; mother-driven effects in relation to self-regulation and maternal mental health; and, a combined model including self-regulation, behavioural outcomes and maternal mental health. Estimates are provided in the tables in both unstandardised and standardised forms. Only the relationships of substantive interest are shown in the figures in order to improve clarity for the reader. Where particular relationships have been previously estimated and reported these are not repeated in subsequent sections. For example, the cross-sectional correlations among the self-regulation indices were reported in the previous chapter and are not repeated in this chapter. The effect of the control variables on the self-regulation indices are reported for the first model below, but not for subsequent models. This is because the role of the control variables across models was consistent and repetition of the results would only add additional unnecessary text and reduce clarity for the reader. In addition, the measurement parts of the models that document the relationship of the latent variables of sleep regulation, reactivity and persistence to their indicator variables are also not replicated. The reader is referred to Chapter 4 for these results.

5.3.1 Descriptive statistics

All variables were examined for outliers and for signs of non-normality. Scores for kurtosis and skew for all variables fell within the recommended ranges for use in SEM (Kline, 2011). Correlations among the continuous variables used in the following analyses are displayed in Table 5.1, along with score ranges, means and standard errors. Correlations were all modest excluding the need for concern regarding multicollinearity. Histograms for these variables are provided in Appendix G. A total of 355 (12.3%) of the mothers in the sample responded "yes" to the single history of depression item used as a control variable.

Table 5.1 *Bivariate correlations, means and SEs for SED, SDQm, SDQt, and MMH*

	SDQm	SDQt	MMH1	MMH2	MMH3	MMH4	SED
SDQ Total Problems Score – mother-report (SDQm)	1						
SDQ Total Problems Score – teacher-report (SDQt)	.425*	1					
Maternal mental health Wave 1 (MMH1)	.196*	.045*	1				
Maternal mental health Wave 2 (MMH2)	.218*	.084*	.468*	1			
Maternal mental health Wave 3 (MMH3)	.237*	.061*	.465*	.469*	1		
Maternal mental health Wave 4 (MMH4)	.332*	.093*	.452*	.463*	.571*	1	
Socio-economic disadvantage (SED)	.179*	.105*	.059*	.073*	.069*	.088*	1
Range	0 - 31	0 - 35	0 – 3.83	0 – 4	0 – 4	0 - 4	-2.93 – 3.99
Mean	7.676	5.219	.5567	.456	.512	.494	-.194
SE	.0911	.095	.01	.009	.010	.01	.0178

* Correlation is significant ($p < .05$)

5.3.2 Self-regulation from birth to 5 years and prediction of behavioural problems at 6-7 years.

In this model, all potential paths from each self-regulation latent variable at each wave, to both teacher-reported and mother-reported behaviour problems at 6-7 years were estimated. It was hypothesised, that if these relationships were confirmed, the path coefficients would be negative. That is, that higher regulatory skill would be associated with lower scores on the SDQ Total Problems Score.

The effects of child gender, SED and history of maternal depression were controlled for by initially estimating a fully saturated model in which each of the self-regulation and outcome variables were regressed onto each of the three control variables. Non-significant paths in relation to the control variables were then trimmed as recommended by Little (2013). There were no relationships found between history of maternal depression and Wave 3 sleep, reactivity and persistence, and Wave 2 reactivity. There were no relationships between child gender and Wave 2 sleep, reactivity and persistence. There were also no relationships between socio-economic disadvantage (SED) and Wave 1 sleep, Wave 2 persistence and Wave 3 reactivity. These paths were therefore trimmed.

The trimmed model was a 'good' fit to the data (x^2 = 1765.337, df = 563, p = .000, CFI = .963, TLI = .956, RMSEA = .027; WRMR = 1.483). There were no large modification indices that made substantive sense and so this model was accepted as the final model. Unstandardised and standardised estimates can be found in Table 5.2. Figure 5.1 provides the standardised estimates for the significant paths in the substantive part of the model only and also the r-squares for the outcome variables. In the interests of clarity for the reader, the paths associated with the control variables are not shown in the figure, but estimates can be found in the final two sections of Table 5.2. Non-significant paths are also not shown.

Results show that reactivity at Wave 2 (β = -.085) and Wave 3 (β = -.069) and persistence at Wave 3 (β = -.136) were significant predictors of Wave 4 teacher-reported behaviour problems in the expected direction. That is, children with higher levels of emotional regulation (reactivity) from 2 to 5 years old and higher cognitive regulation (persistence) at 4-5 years were more likely to have fewer behaviour problems as perceived by their teachers at 6-7 years old. Mother-reported behaviour problems at Wave 4 were predicted by reactivity at Wave 2 (β = -.020) and Wave 3 (β = -.210) and persistence at Wave 2 (β = -.109) and Wave 3 (β = -.126), also in the expected direction. Sleep regulation did not directly predict behaviour problems at any wave. The three control variables were significantly related to both mother-reported and teacher-reported behaviour problems as anticipated. A significant history of maternal depression, higher levels of socio-economic disadvantage, and being a boy were all related to higher scores on the SDQ Total Problems Score as reported by both teachers and mothers. The model accounted for just under 10% of variance in teacher-reported behaviour problems and almost 26% of variance in mother-reported behaviour problems.

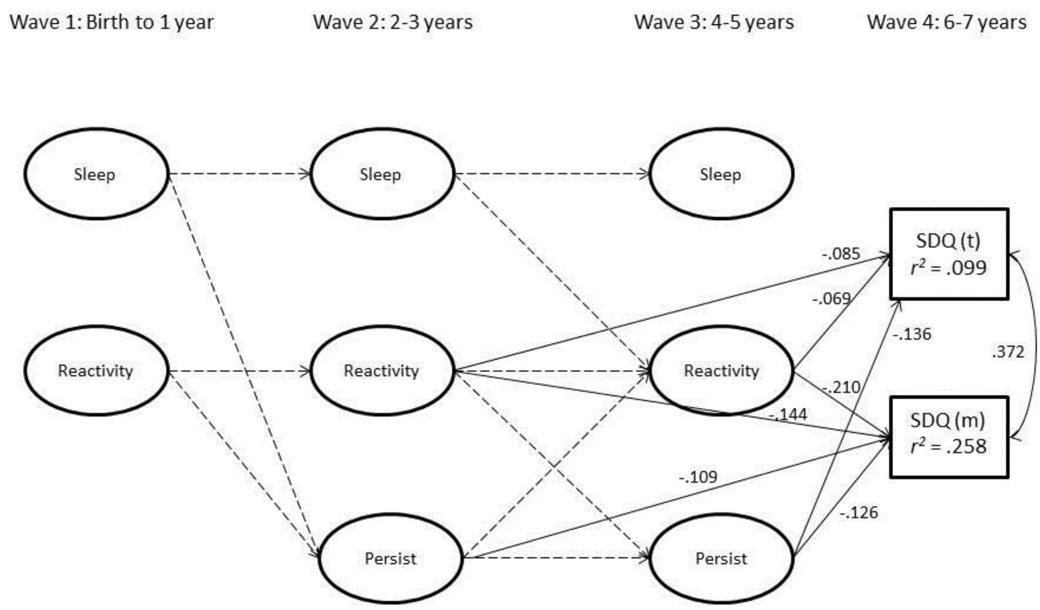

Figure 5.1. Final model for the relationship of early childhood self-regulation to later behaviour problems. All estimates are standardised. Dashed lines are significant regression paths included in the model but estimates are not provided. Non-significant paths are not shown. Fit statistics: x^2 = 1765.337, *df* = 563, *p* = .000, CFI = .963, TLI = .956, RMSEA = .027 (CI .026 - .029), WRMR = 1.483. SDQ(t) = teacher-reported behaviour problems; SDQ(m) = mother-reported behaviour problems.

Table 5.2 *Structural model estimates for the relationship betweem early self-regulation and later social, emotional and behavioural problems for children*

Parameter	Unstandardised *(se)*	Standardised	*p*
Structural model estimates: teacher-reported behaviour problems			
Sleep Wave 1⟶ SDQt	.409 (.390)	.063	.293
Reactivity Wave 1 ⟶ SDQt	.650 (.372)	.083	.081
Sleep Wave 2 ⟶ SDQt	-.745 (.492)	-.103	.130
Reactivity Wave 2 ⟶ SDQt	-.564 (.202)	-.085	.005
Persistence Wave 2 ⟶ SDQt	.148 (.237)	.020	.532
Sleep Wave 3 ⟶ SDQt	.325 (.462)	.042	.482
Reactivity Wave 3 ⟶ SDQt	-.540 (.262)	-.069	.040
Persistence Wave 3 ⟶ SDQt	-.834 (.147)	-.136	.000
Structural model estimates: mother-reported behaviour problems			
Sleep Wave 1→ SDQm	.152 (.325)	.024	.640
Reactivity Wave 1 → SDQm	-.150 (.309)	-.020	.627
Sleep Wave 2 → SDQm	.111 (.396)	.016	.780
Reactivity Wave 2 → SDQm	-.912 (.177)	-.144	.000
Persistence Wave 2 → SDQm	-.783 (.207)	-.109	.000
Sleep Wave 3 → SDQm	-.638 (.363)	-.087	.079
Reactivity Wave 3 → SDQm	-1.572 (.221)	-.210	.000
Persistence Wave 3 → SDQm	-.742 (.127)	-.126	.000
Covariance SDQt and SDQm	7.611 (.384)	.372	.000
Control variables: relation to outcome measures			
Gender (boy) → SDQt	1.698 (.201)	.341	.000
Gender (boy) → SDQm	.706 (.171)	.150	.000
SED → SDQt	.300 (.103)	.056	.004
SED → SDQm	.553 (.093)	.108	.000
History of maternal depression → SDQt	1.038 (.263)	.209	.000
History of maternal depression → SDQm	1.374 (.225)	.291	.000
Control variables: relation to self-regulation latent variables			
Gender (boy) → sleep Wave 1	-.106 (.044)	-.067	.015
Gender (boy) → reactivity Wave 1	-.085 (.032)	-.066	.007
Gender (boy) → sleep Wave 3	.077 (.035)	.058	.029
Gender (boy) → reactivity Wave 3	-.087 (.028)	-.067	.002
Gender (boy) → persistence Wave 3	-.200 (.033)	-.120	.000
SED → reactivity Wave 1	.037 (.016)	.054	.021
SED → sleep Wave 2	-.081 (.017)	-.129	.000

Parameter	Unstandardised *(se)*	Standardised	*p*
SED → reactivity Wave 2	-.130 (.017)	-.161	.000
SED → sleep Wave 3	-.041 (.019)	-.059	.032
SED → persistence Wave 3	-.081 (.017)	-.093	.000
History of maternal depression → sleep Wave 1	-.246 (.068)	-.103	.000
History of maternal depression → reactivity Wave 1	-.143 (.046)	-.072	.002
History of maternal depression →sleep Wave 2	-.167 (.056)	-.078	.003
History of maternal depression → reactivity Wave 2	-.197 (.049)	-.084	.000

SED = Socio-economic disadvantage; SDQt and SDQm = teacher- and mother-reported behaviour problems on the Total Problems Score of the *Strengths and Difficulties Questionnaire*

The lower section of Table 5.2 provides the estimates for the relationship of the control variables to each of the self-regulation indicators. While all the analyses that follow in this and the following thesis chapters controlled for maternal history of depression, child gender and socio-economic disadvantage, these results will not be provided in subsequent analyses where the variables used for modelling remain the same. The pattern of results found here remained the same throughout the progression of analyses. That is, that being a boy was related to poorer sleep regulation at Wave 1 (β = -.106) but better sleep regulation at Wave 3 (β = .077). Being a boy was also associated with poorer emotional regulation (reactivity) at Wave 1 (β = -.085) and Wave 3 (β = .087) and poorer cognitive regulation (persistence) at Wave 3 (β = -.200). A higher level of socio-economic disadvantage was associated with poorer sleep regulation at each of Wave 2 (β = -.081) and Wave 3 (β = -.041) and poorer emotional regulation at Wave 2 (β = -.130), but better emotional regulation at Wave 1 (β = .037). Higher SED was also related to poorer cognitive regulation at Wave 3 (β = -.081). A history of maternal depression was associated with poorer sleep regulation at Wave 1 (β = -.246) and Wave 2 (β = -.167) and poorer emotional regulation at Wave 1 (β = -.143) and Wave 2 (β = -.197).

Five paths involving mediation were apparent in the figure. The effect of Wave 2 reactivity on Wave 4 teacher-reported behavioural problems appeared to be mediated by Wave 3 reactivity and also by Wave 3 persistence. The effect of Wave 2 reactivity on mother-reported behaviour problems at Wave 4 appeared to be mediated by Wave 3 persistence. Finally, the effect of Wave 2 persistence on mother-reported behaviour problems appeared to be mediated by Wave 3 reactivity and persistence. For partial mediation to be claimed the indirect paths as described need to be statistically significant and so this was tested by requesting estimates for these pathways in Mplus. The bootstrap method as recommended by MacKinnon (2012) was implemented. Results of these analyses are presented in Table 5.3 and show that each of the indirect pathways were significant. The total effects (direct plus indirect) of Wave 2 reactivity on Wave 4 behaviour problems was one of the strongest in the model at β = -.269 (p = .000). The total effect of Wave 2 persistence on Wave 4 mother-reported behaviour problems was also relatively strong at β = -.203 (p = .000). The total effect of Wave 2 reactivity on Wave 4 teacher-reported behaviour problems was small but significant at β = -.106 (p = .000).

Table 5.3 *Parameter estimates for the indirect paths between early self-regulation and later mother- and teacher-reported behaviour problems*

	STQ (Mother-report)			**SDQ (Teacher-report)**		
	β *(se)*	***β***	***p***	**β *(se)***	***β***	***p***
Reactivity Wave 2 → Reactivity Wave 3	ns			-.222 (.108)	-.034	.040
Reactivity Wave 2 → Persistence Wave 3	-.116 (.026)	-.018	.000	-.130 (.030)	-.020	.000
Persist Wave 2 → Reactivity 3	-.353 (.061)	-.049	.000	ns		
Persistence Wave 2 → Persistence Wave 3	-.387 (.068)	-.054	.000	ns		
Total effect for Reactivity Wave 2		-.269	.000		-.106	.000
Total effect for Persistence Wave 2		.203	.000			

ns = non-significant

5.3.3 Child-driven effects of self-regulation on maternal mental health from birth to 7 years

In this model, longitudinal relationships between children's self-regulation and maternal mental health over the first seven years were examined from a child-driven perspective. The hypothesis that children with poorer regulation skills would lead to mothers with poorer mental health was tested. Maternal mental health (MMH) was measured at each wave of LSAC via the Kessler K6 screener. The final cross-lagged model developed in Study 1 which included the latent variables of sleep regulation, reactivity and persistence was once again used as the basis for this study. A longitudinal panel model was developed that included maternal mental health measured at each wave. This allowed for prior levels of maternal mental health difficulties to be controlled for and provides a greater degree of confidence in the findings than if only a single time-point measure were used (Little, 2013). Higher scores on the K6 reflect a higher degree of psychological distress symptoms.

Once again, correlations among the latent variables of sleep regulation, reactivity and persistence at each wave were estimated but are not shown in the following figure or tables of results. In addition, these self-regulation indicators were also allowed to correlate with the corresponding maternal mental health measure at each wave. All potential cross-lagged paths from self-regulation variables at one wave to maternal mental health at the next wave were estimated. That is, maternal mental health at Wave 2 was regressed onto Wave 1 sleep regulation and reactivity, maternal mental health at Wave 3 was regressed onto Wave 2 sleep regulation, reactivity and persistence, and so on. This model tested the hypothesis that having a child with poorer self-regulation skills leads to poorer mental health for mothers, even when a significant history of maternal depression and prior levels of maternal mental health are controlled for. The hypothesised model, with the substantive paths of interest indicated, is displayed in Figure 5.2.

The significant paths between the control variables and the self-regulation indicators as found in the previous analysis were included in this model. In addition, the effects of child gender, socio-economic disadvantage and significant history of maternal depression were controlled for in relation to maternal mental health at each of the four waves. In line with recent recommendations by Little (2013), non-significant paths related to control variables were then trimmed. There were no significant relationships between child gender and maternal mental health at any wave, and no relationship between socio-economic disadvantage and maternal mental health at Waves 1, 3 and 4. These paths were therefore trimmed and the model was re-estimated.

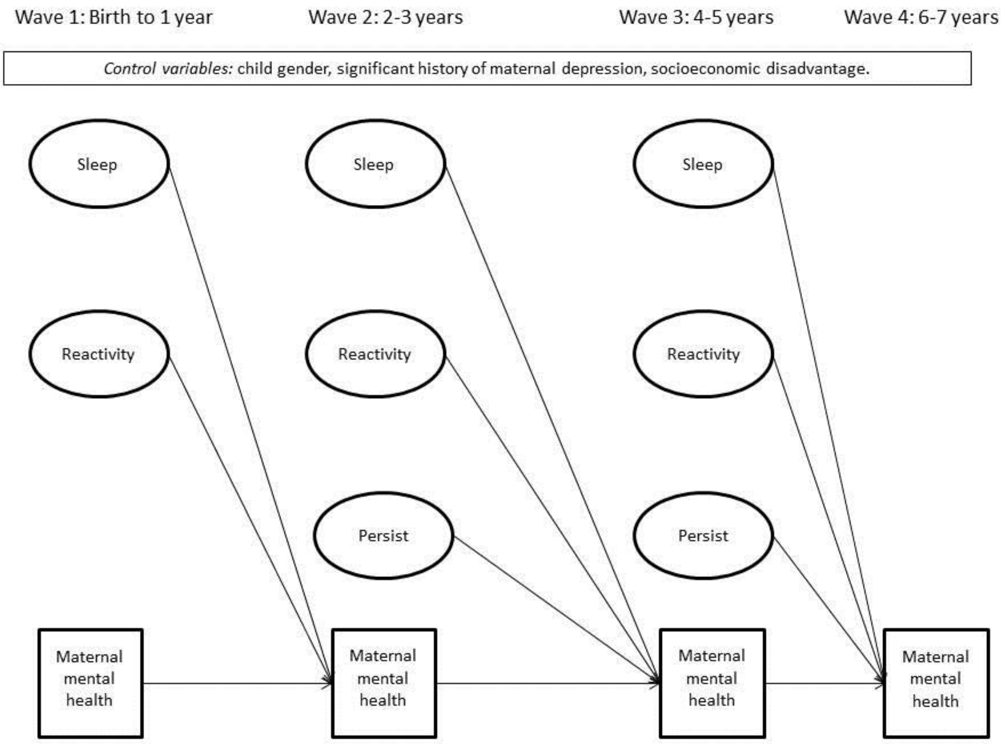

Figure 5.2. Hypothesised model for the child-driven effects of child self-regulation on maternal mental health.

This model (Model A) fit the data ‘adequately’ (RMSEA = .031, CFI = .950, TLI = .943) as displayed in Table 5.3. One large modification index for the regression of maternal mental health at Wave 3 on maternal mental health at Wave 1 made substantive sense and so this path was estimated in the next model. This model (Model B) had improved fit indices resulting in the model having ‘good’ fit to the data (RMSEA = .028, CFI = .960, TLI = .953). Formal statistical testing of model fit improvement was not possible due to the models being non-nested. However, an increase in the CFI of greater than .002 was observed, indicating that this model was a substantially better fit to the previous model (Meade, Johnson, & Braddy, 2008).

Table 5.4 *Fit indices for child-driven models estimating the relationship between self-regulation and maternal mental health*

Model	Chi-square *(df)*	*p*	RMSEA (90% confidence interval)	CFI	∆CFI	TLI	WRMR
Recommended cut off values		*>.05*	*< .5*	*>.95*	*>.002*	*>.95*	*<1*
A (baseline)	2410.555 (637)	.000	.031 (.030 - .032)	.950	---	.943	1.678
B (MMH3 → MMH1)	2135.982 (636)	.000	.029 (.027 - .030)	.958	.008	.951	1.573

Unstandardised and standardised estimates can be found in Table 5.5. Figure 5.3 provides the standardised estimates for the significant paths in the substantive part of the model only. In the interests of clarity for the reader, the paths associated with the control variables are not shown in the figure, but estimates can be found in the third section of Table 5.5. Similarly the cross-sectional correlations among the self-regulation and maternal mental health variables are not shown in the figure but can be found in Table 5.5.

Results show that maternal mental health at Wave 4 was predicted by children's sleep regulation (β = -.048) and reactivity (β = -.049) two years earlier (Wave 3). Maternal mental health at Wave 3 was also predicted by children's reactivity two years earlier (β = -.058). These relationships were in the expected direction. That is, that children who had poorer emotional regulation (Wave 2 and Wave 3 reactivity) and poorer sleep regulation (Wave 3), had mothers with more psychological distress symptoms two years later (Wave 3 and 4 respectively). Estimates were small, however were significant in spite of the fact that the model accounted for the prior mental health status of mothers and their significant history of depression prior to Wave 1 data collection.

The strongest predictors of future maternal mental health for mothers were their previous mental health status and a history of depression. A significant history of depression strongly predicted Wave 1 maternal mental health (β = 1.014), which then strongly predicted Wave 2 (β = .423) and Wave 3 (β = .330) maternal mental health. Wave 4 maternal mental health was strongly predicted by maternal mental health two years earlier (β = .655). The model accounted for just over 50% of the variance in maternal mental health at Wave 4 with children's reactivity at Wave 2 and Wave 3 and sleep regulation at Wave 3 contributing small but unique variance in this analysis.

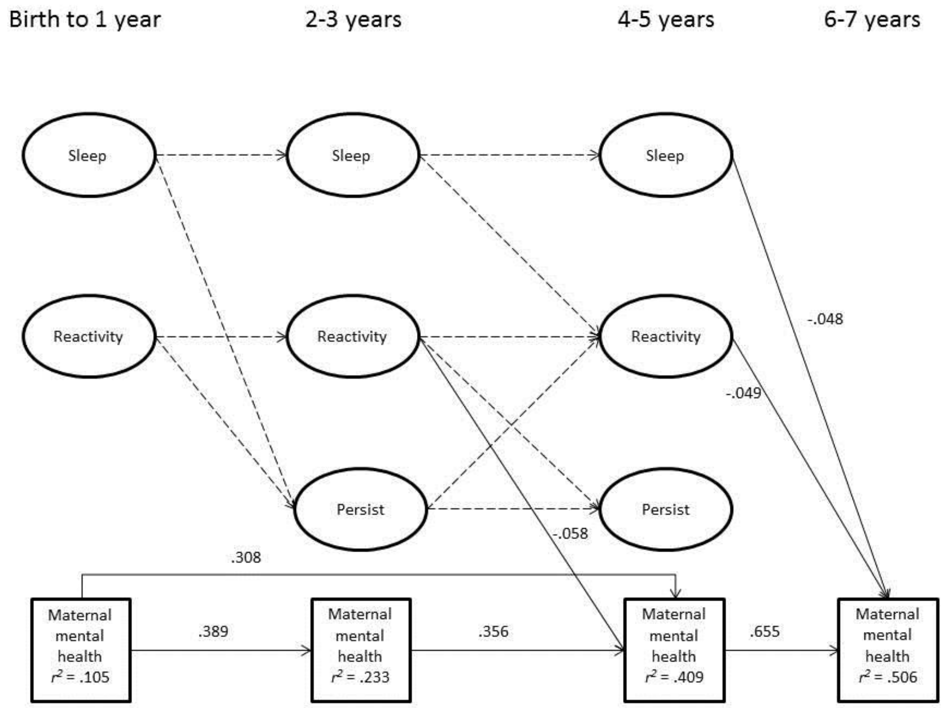

Figure 5.3. Final model for the child-driven effects of child self-regulation on maternal mental health. All estimates are standardised. Dashed lines are significant regression paths included in the model but estimates are not provided. Fit statistics: x^2 = 2138.919, *df* = 636, *p* = .000, CFI = .958, TLI = .951, RMSEA = .029 (CI .027 - .030), WRMR = 1.573.

Table 5.5 *Structural model estimates for the child-driven model estimating the relationship between self-regulation and maternal mental health*

Parameter	Unstandardised *(se)*	Standardised	*p*
Structural model estimates			
Sleep Wave 1 → MMH Wave 2	-.035 (.028)	-.048	.276
Reactivity Wave 1 → MMH Wave 2	-.003 (.033)	-.004	.925
Sleep Wave 2 → MMH Wave 3	-.010 (.017)	-.013	.574
Reactivity Wave 2 → MMH Wave 3	-.038 (.013)	-.058	.004
Persistence Wave 2 → MMH Wave 3	-.005 (.014)	-.007	.688
Sleep Wave 3 → MMH Wave 4	-.039 (.018)	-.048	.030
Reactivity Wave 3 → MMH Wave 4	-.040 (.016)	-.049	.014
Persistence Wave 3 → MMH Wave 4	-.003 (.011)	-.005	.775
Total effect Reactivity Wave 2 → MMH Wave 4	-.044 (.011)	-.063	.000
Estimates for the stability of maternal mental health			
MMH Wave 1 → MMH Wave 2	.389 (.012)	.423	.000
MMH Wave 2 → MMH Wave 3	.356 (.010)	.351	.000
MMH Wave 3 → MMH Wave 4	.701 (.015)	.655	.000
MMH Wave 1 → MMH Wave 3	.308 (.011)	.330	.000
Control variables: relation to maternal mental health			
SED → MMH Wave 2	.030 (.012)	.058	.020
History of maternal depression → MMH Wave 1	.518 (.022)	1.014	.000
History of maternal depression → MMH Wave 2	.149 (.021)	.310	.000
History of maternal depression → MMH Wave 3	.136 (.021)	.265	.000
History of maternal depression → MMH Wave 4	.148 (.020)	.288	.000
Cross-sectional covariances: maternal mental health and self-regulation variables			
Wave 1 MMH and sleep	-.076 (.011)	-.190	.000
Wave 1 MMH and reactivity	-.105 (.008)	-.335	.000
Wave 2 MMH and sleep	-.032 (.008)	-.126	.000
Wave 2 MMH and reactivity	-.059 (.007)	-.191	.000
Wave 2 MMH and persistence	-.036 (.007)	-.133	.000
Wave 3 MMH and sleep	-.076 (.008)	-.098	.026
Wave 3 MMH and reactivity	-.031 (.006)	-.160	.000
Wave 3 MMH and persistence	-.005 (.008)	-.018	.506

MMH = maternal mental health

5.3.4 Mother-driven effects of maternal mental health on children's self-regulation from birth to 5 years

In this model, longitudinal relationships between children's self-regulation and maternal mental health over the first seven years were examined from a mother-driven perspective. This model investigated the hypothesis that mothers with poorer mental health would give birth to, and raise children with poorer self-regulation skills. A similar process to model development as described above was used. The differences were that cross-lagged paths were reversed in their direction. That is, that sleep, reactivity and persistence were regressed onto the maternal mental health variable measured two years earlier, while prior levels of maternal mental health and a significant history of depression were controlled for. The hypothesised model is displayed in Figure 5.4. It was anticipated that if relationships were found, the path estimates would again be negative (i.e., mothers who had higher psychological distress symptoms would have children with lower self-regulation scores two years later).

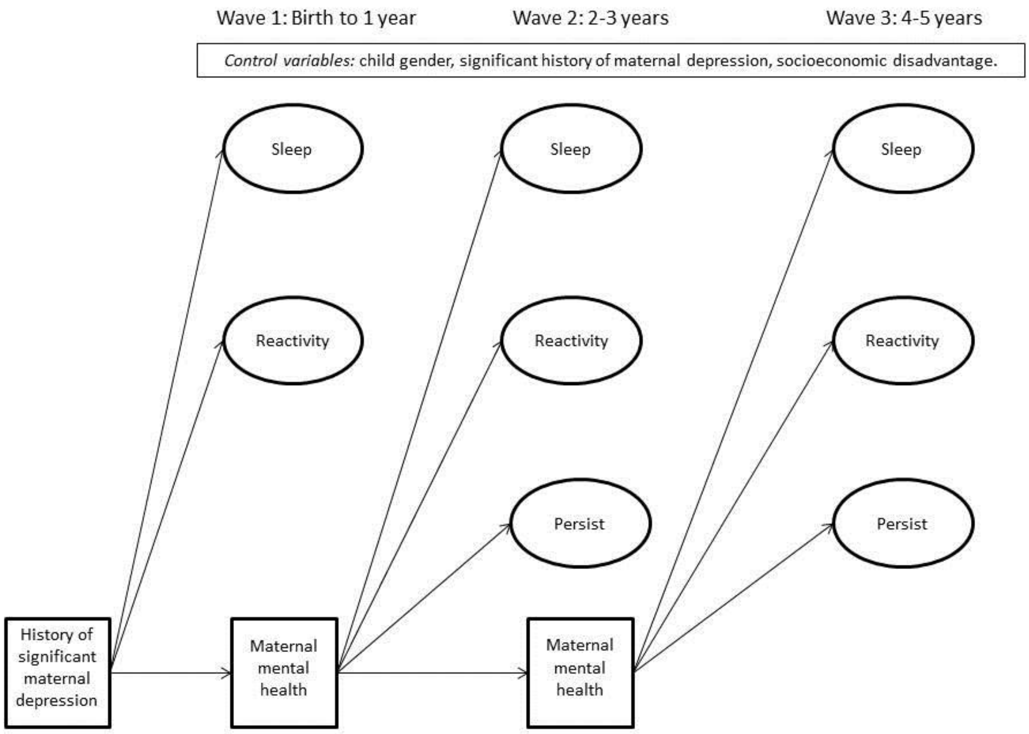

*Figure 5.4.*Hypothesised model for the mother-driven effects of maternal mental health on child self-regulation.

Once again, the effects of child gender, socio-economic disadvantage and significant history of maternal depression were controlled for in relation to maternal mental health. The initial model was a ‘good’ fit to the data (RMSEA = .027, CFI = .963, TLI = .957) and so was retained as the final model.

Unstandardised and standardised estimates can be found in Table 5.6. The relationships between maternal mental health and the control variables at each wave are not repeated but were similar to those documented in Table 5.5 above. The relationships between Wave 1 sleep regulation and reactivity and the control variable of history of maternal depression are shown in the table as these paths are of interest to the hypothesis that maternal mental health drives poorer self-regulation in children. Figure 5.5 provides the standardised estimates for the significant paths in the substantive part of the model only.

Results show that maternal mental health at Wave 1 predicted children’s sleep regulation (β = -.059), reactivity (β = -.112) and persistence (β = -.056) two years later. Maternal mental health at Wave 2 also predicted children’s reactivity at Wave 3 (β = -.098). Each of these relationships were in the expected direction. That is, that higher rates of psychological symptoms in mothers predicted poorer sleep regulation, emotional regulation (reactivity) and cognitive regulation (persistence) in children two years later, particularly in the birth to 3-years period. A significant history of depression (two years or more) prior to Wave 1 data collection also predicted poorer sleep regulation (β = -.109) and reactivity (β = -.064) in children at Wave 1. Estimates were small but significant, confirming the hypothesis that poorer maternal mental health is related to lower levels of self-regulation in children over time, particularly in the first three years. These effects held even though prior levels of children’s regulatory capacity were accounted for.

Table 5.6 *Structural model estimates for the mother-driven model estimating the relationship between self-regulation and maternal mental health*

Parameter	**Unstandardised *(se)***	**Standardised**	***p***
Structural model estimates			
MMH Wave 1 → sleep Wave 2	-.079 (.038)	-.059	.040
MMH Wave 1 → reactivity Wave 2	-.161 (.033)	-.112	.000
MMH Wave 1 → persistence Wave 2	-.072 (.030)	-.056	.016
MMH Wave 2 → sleep Wave 3	-.028 (.036)	-.020	.439
MMH Wave 2 → reactivity Wave 3	-.131 (.027)	-.098	.000
MMH Wave 2 → persistence Wave 3	.046 (.032)	.027	.149
Estimates for relationship between Wave 1 regulation and history of significant maternal depression			
History of maternal depression → sleep Wave 1	-.264 (.068)	-.109	.000
History of maternal depression → reactivity Wave 1	-.124 (.046)	-.064	.007
Estimates for the stability of maternal mental health			
History of maternal depression → MMH Wave 1	.519 (.022)	1.96	.000
MMH Wave 1 → MMH Wave 2	.419 (.011)	.452	.000

MMH = maternal mental health

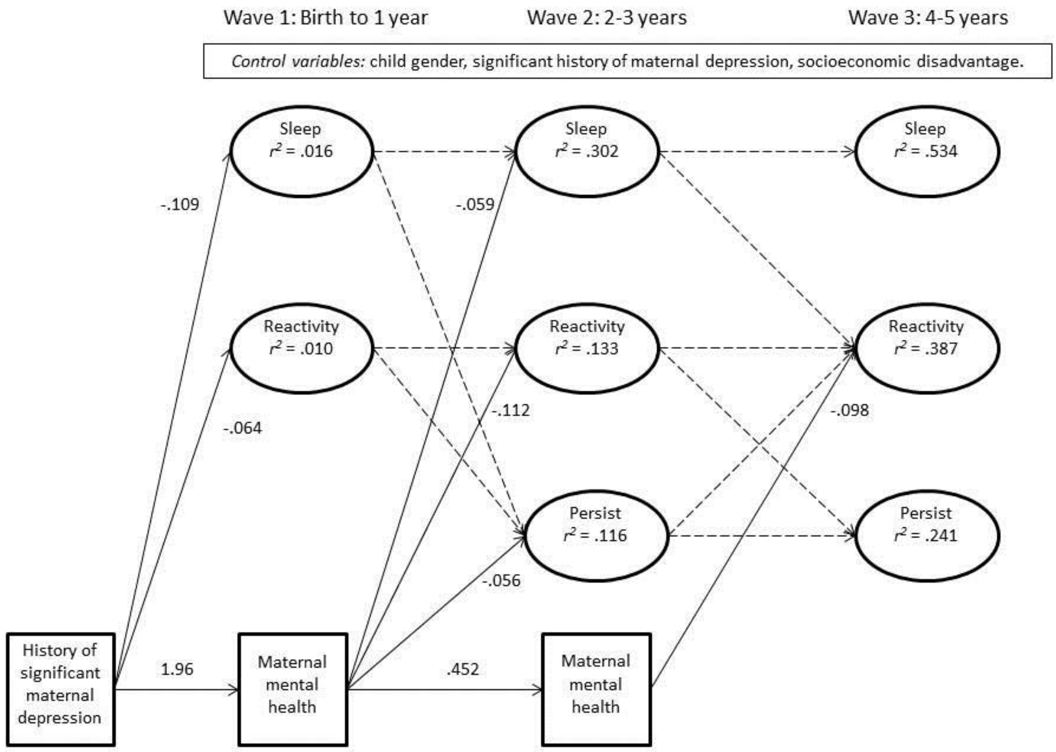

Figure 5.5. Final longitudinal model for the mother-driven effects of maternal mental health on child self-regulation. All estimates are standardised. Dashed lines are significant regression paths included in the model but estimates are not provided. Fit statistics: x^2 = 1774.981, *df* = 571, *p* = .000, CFI = .963, TLI = .957, RMSEA = .027 (CI .026 - .028), WRMR = 1.490.

5.3.5 Combined longitudinal panel model of self-regulation, maternal mental health and behavioural outcomes

The final model in this study combined each of the above three models in order to explore the ways in which both children's self-regulation and maternal mental health contribute to mother-reported and teacher-reported behaviour problems at 6-7 years of age. The model included all significant paths from the above three analyses. In addition, the path from Wave 3 maternal mental health to Wave 4 mother-reported and teacher-reported behaviour problems was included and Wave 4 mother-reported and teacher-reported behaviour problems were correlated with Wave 4 maternal mental health. This model was a 'good' fit to the data (RMSEA = .028, CFI = .957, TLI = .950). All hypothesised relationships developed as a result of the three models described above held except for the regression of Wave 2 sleep regulation on Wave 1 maternal mental health (*p* = .064; from the mother-driven model), Wave 4 maternal mental health on Wave 3 sleep (*p* = .063; from the child-driven model) and Wave 4 teacher-reported behaviour problems on Wave 3 reactivity (*p* = .053; from the outcome model). Maternal mental health at Wave 3 did not predict teacher-reported behaviour problems at Wave 4 as hypothesised (*p* = .433), but did predict mother-reported behaviour problems (β = .151). Wave 4 maternal mental health was not correlated with teacher-reported behaviour problems (*p* = .123) but was correlated with mother-reported behaviour problems (β = .169). Due to the complexity of the model, Figure 5.6 uses the formatting of the lines designating the paths to indicate the strength of the relationships, rather than providing the actual estimates. The exception to this is where a path had not previously been estimated. Estimates not shown were very similar to those found in the tables throughout this chapter and so are not repeated in the figure or in table form.

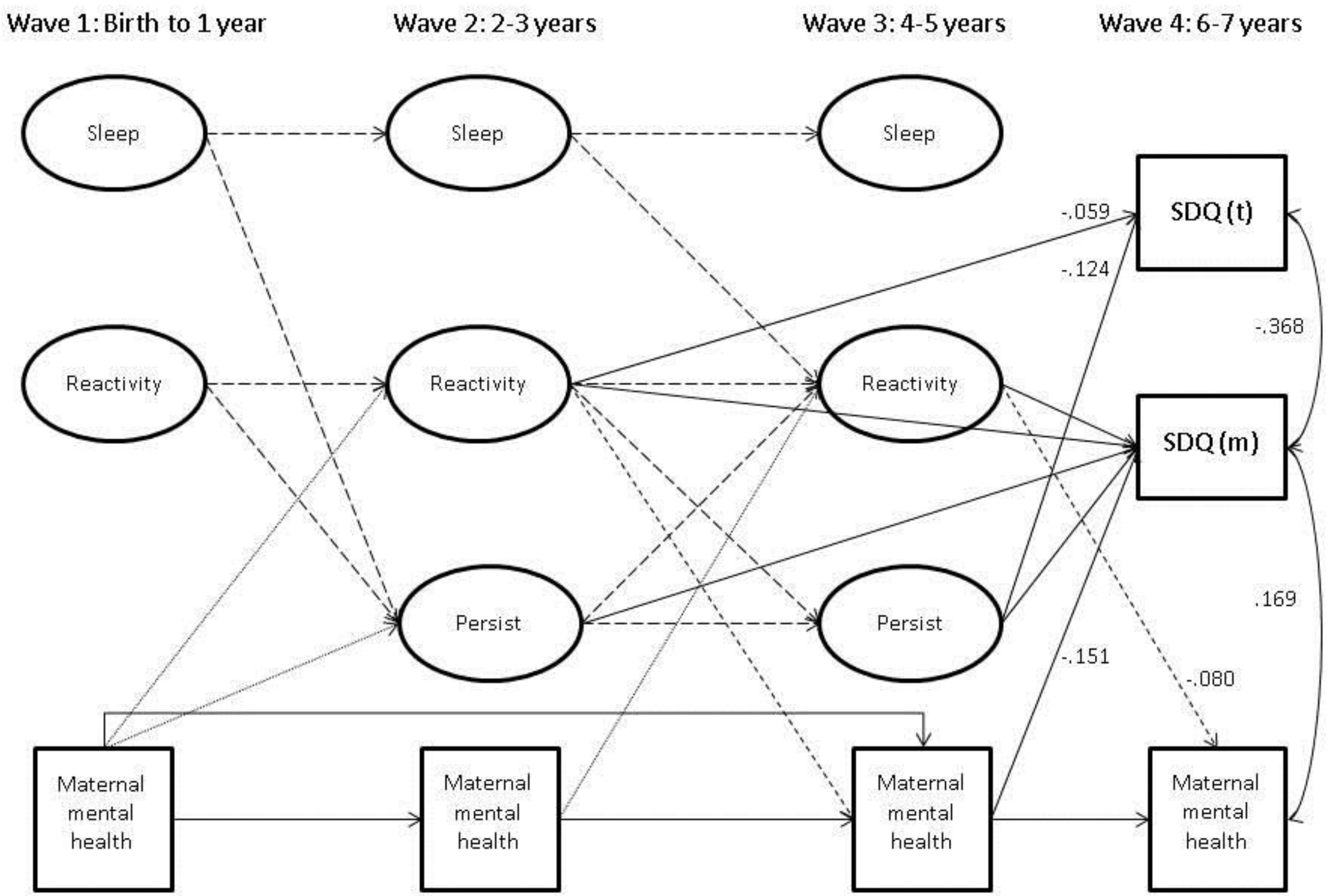

Figure 5.6. Final longitudunal model for the interactions of maternal mental health and child self-regulation and associations with behavioural problems. Solid lines = standardised estimates >. 30; long dash lines: standardised estimates .20 - .30; short dash lines = standardised estimates .10 - .19; dotted lines = standardised estimates < .10. Only significant paths are shown. Fit statistics: chi-square = 2324.686, df = 704, p = .000, CFI = .957, TLI = .950, RMSEA = .028 (CI .027 - .030), WRMR = 1.5.

This model accounted for almost 50% of the variance in maternal mental health at Wave 4, 25% of the variance in mother-reported behaviour problems and a small 3.6% of variance in teacher-reported behaviour problems. In examination of the relative strength of the relationships between variables a pattern emerges. The strongest effect sizes were those related to the continuity of sleep regulation, reactivity, persistence and maternal mental health over time. The next strongest effect sizes were generally for the cross-lagged paths reflecting heterotypic continuity among the self-regulation indicators over time. These were followed by the paths predicting Wave 4 mother-reported and teacher-reported behaviour problems from reactivity, persistence and maternal mental health measured two years earlier. Finally, the weakest effect sizes came from the child and mother-driven models linking maternal mental health and child self-regulation over time.

5.4 Discussion

Study 2 explored the research question: How is self-regulation from birth to age 5 associated with maternal mental health across time, and children's social, emotional and behavioural outcomes at age 6-7? In Study 1, latent variables of sleep regulation, reactivity (indicative of emotional regulation) and persistence (indicative of cognitive regulation) were developed across three waves of data. These were used in Study 2 as the basis for a series of four longitudinal SEMs which explored the ways in which early self-regulation predicted later social, emotional and behavioural outcomes for children, and the ways in which children's self-regulation is related to maternal mental health over time. In particular, the second and third models explored the longitudinal mother-driven and child-driven effects of children's self-regulation in relation to maternal mental health. The final model was developed using the results of the first three models and provides insight into the complex relationships that exist between the constructs of interest during the period of early childhood.

The discussion of results that follows must be interpreted with caution given the limitations of this study. The same sources of misfit that meant that the measurement models presented in the preceding chapter did not fit the data perfectly, continued to contribute to misfit in the substantive models presented in this chapter. Equally, the issues concerning longitudinal measurement invariance and shared method variance (mother report only) first introduced in Chapter 4 are equally relevant here. The use of teacher-report data in regards to the outcome measure in this study is an important strength. The findings suggest there is a degree of predictive validity in regards to earlier maternal report of children's regulatory problems and later behavioural problems observed in the school context by an observer independent to the mother-child dyad.

5.4.1 Early self-regulation predicts later behaviour problems

The first model showed evidence for the predictive validity of the early childhood self-regulation measures developed in Study 1 in relation to behaviour problems at 6-7 years. Teacher-reported behaviour problems were predicted by reactivity in the third and fifth years and persistence in the third year. Mother-reported behaviour problems were predicted by both reactivity and persistence measured in the third and fifth years. All relationships were in the expected direction. Specifically, higher regulatory capacity (as indicated by reactivity and persistence) was associated with fewer behaviour problems. These findings concur with other longitudinal studies which have found early measures of emotional and cognitive regulation to be predictive of later social, emotional and behavioural outcomes (Kim & Deater-Deckard, 2011; Olson et al., 2011; Ramani et al., 2010). Importantly, this study contributes empirical evidence that is unique to the Australian context. Support for the predictive validity of mother-reported child regulation in relation to teacher-reported behaviour problems is particularly important. If this was not the case, a significant methodological weakness would be apparent because of the suggestion that mother's negative views of their children continued to influence their ratings of their behaviour over time.

It is interesting to note that the measures taken in infancy did not predict later outcomes. The predictive power of reactivity and persistence began at 2-3 years and generally increased over time, with additive effects shown by the number of significant indirect pathways stemming from these self-regulation indicators at this time. This appears to also reflect the extent to which homotypic stability in these constructs is present across these years. The longitudinal analysis in Study 1 found that continuity increased from this age. This indicates that the period from birth to 3 years, where these traits are less stable, may be a window of opportunity to effect change in the early self-regulatory characteristics of children.

Persistence at 2-3 years was not predictive of teacher-reported behaviour problems, but persistence at 4-5 years was. Further, persistence at 4-5 years was an important mediator of the effects of earlier self-regulation on later behaviour problems. This suggests a second window of opportunity from the age of 3 to 5 years in which parents and early childhood settings might effect change in children's cognitive regulation in particular in an effort to prevent the development of later behavioural problems in school settings. The persistence construct was only moderately stable across this time and so the capacity for change is clearly present.

Although it was hypothesised that sleep regulation would also be predictive of later behavioural outcomes, evidence for this was not found. This is in contrast to other studies that do find sleep problems to be associated with poorer social and behavioural development in children (O'Callaghan et al., 2010; Quach et al., 2012; Schmid et al., 2010). However, these studies do not include other measures of self-regulation in their models. In the current study, sleep regulation during the third year did predict reactivity during the fifth year, which in turn was a consistent predictor of both teacher-reported and mother-reported behaviour problems. It may be that sleep regulation impacted on behaviour through this indirect path only. The lack of direct relationships between sleep regulation and later outcomes may also relate to measurement problems in the current study whereby mother-reported sleep regulation from 2-3 years was potentially a reflection of parenting practices (Bordeleau et al., 2012) or issues in parental psychosocial functioning (Bernier et al., 2012). This is a limitation in the current study that will be further addressed in Chapter 8.

5.4.2 Maternal mental health and self-regulation: Mother- and child-driven effects

The second and third models estimated in this study examined the child-driven and mother-driven effects in regards to children's self-regulation and mothers' mental health over time. Very few longitudinal studies have examined these relationships and there is little empirical data to support child-driven effects despite the fact that transactional models of child development suggest that these are potentially present (Pesonen et al., 2008). Analyses conducted for this study provide evidence for both mother- and child-driven effects. Mothers with a history of depression were more likely to have infants with poor sleep and reactivity as measured during the first year. Mothers with poorer mental health at Wave 1 were also more likely to have children with poorer sleep, reactivity and persistence two years later. Finally, poorer maternal mental health measured at 2-3 years was associated with poorer reactivity in children two years later. These findings concur with others that have found prenatal maternal depression to be associated with poor infant sleep regulation very early in life (Armitage et al., 2009; Field et al., 2007) and maternal stress in infancy to be related to lower levels of attentional and emotional regulation at age 5 (Pesonen et al., 2008).

It is interesting to note that the predictive power of maternal mental health in relation to later self-regulation for children tended to decrease over time. Maternal mental health measured in the third year was no longer predictive of sleep regulation or persistence two years later. It may be that the effect of maternal mental health on children's developing regulation skills is somewhat complete by the age of 3 years, the same time point from which higher degrees of stability in self-regulation were found.

Evidence was also found to support child-driven effects. Even when mothers' prior mental health was accounted for, children with poorer reactivity measured in the third year were associated with poorer maternal mental health two years later, and poor sleep and reactivity in children at 4-5 years of age also contributed small but unique variance to maternal mental health measured two years later. Previous research has found child-driven effects in relation to children's self-regulation skills and parenting behaviours such as teaching strategies (Eisenberg et al., 2010). However, there was no empirical evidence supporting child-driven effects in relation to self-regulation and maternal mental health found in the literature review conducted for this program of study.

It is interesting to note that child-driven effects were not found during the infant period, but rather children's self-regulation from the age of 2 years became predictive of later maternal mental health. The mother-driven model described above suggests that early in life, mother-driven effects are the primary mechanism within the mother-child system. From the age of 2-3 years, ongoing self-regulatory problems in children may continue to exacerbate maternal mental health problems, resulting in the child-driven effects found in these analyses. Such exacerbation might be as a result of children's ongoing poor self-regulation skills interacting with maternal expectations about normative self-regulatory development in children.

Prior research has established that chronic and prolonged infant night waking leads to higher levels of maternal intervention at night, leading to higher levels of sleep deprivation and consequent compromised mental health in mothers (Meltzer & Mindell, 2007). In addition to sleep difficulties, these children are likely to present parenting challenges such as being difficult to soothe and having limited capacity to engage in activities for any sustained period on their own. If these difficulties are still occurring at 2-3 years of age they may present a mismatch with maternal expectations of self-regulation development in children. In combination with a mother who has a pre-existing vulnerability to poor mental health, these children may present an additional drain on mothers' psychological resources which results in ongoing, or exacerbated mental health problems for the mother.

The fact that child-driven effects did not emerge until the 2-3-year-old time point also reflects recent research that suggests that the toddlerhood period is critical in establishing patterns of mother-child dyadic interaction that will influence the development of later behaviour problems (Lorber & Egeland, 2011). During this developmental stage there is a normative spike in the externalising and non-compliant behaviour of children. Similarly, it was not until children were aged 4-5 years that sleep regulation became predictive of mothers' later mental health. As biobehavioural regulation and sleep consolidation is complete for most children by 4-5 years of age (Henderson, France, Owens, & Blampied, 2010), the experience of having a child with ongoing sleep regulation difficulties during this time may be a substantial mismatch to maternal expectations and result in deleterious effects on maternal mental health. The emergence of child-driven effects from 2-3 years suggest that continuing to support mothers in parenting *across* early childhood might be critical. Future research should pursue the mutual exacerbation process further in relation to other aspects of parenting and children's self-regulatory capacity over time.

The final model presented in this chapter was developed by combining the previous three models to allow exploration of both the interactions between child self-regulation and maternal mental health, and the ways in which these factors predict later behavioural problems for children. Although three paths with small effect sizes became insignificant in this model (at the $p < .05$ level), overall, the relationships between the constructs found in the previous models held. This provides evidence of the robustness of the models. The pattern that emerged in regards to the relative strengths of the paths indicates that child self-regulation and maternal mental health are reasonably stable over time. Further, that mother-driven effects are prominent in the first few years, but children's self-regulation measured in the third year begins to have predictive power in relation to later maternal mental health and behavioural outcomes for children.

Taken together these findings indicate that prevention efforts should aim to identify families at risk of poorer outcomes during infancy by assessing maternal history of depression and infants' sleep regulation and reactivity. Interventions should aim to support these families and address the mother-child system in the first three years to minimise the risk of ongoing child self-regulation problems which may exacerbate maternal mental health problems and contribute to behaviour problems at school entry. In addition, mothers with vulnerability to mental health difficulties should be supported right across the early childhood period in an effort to dampen mutual exacerbation processes.

5.4.3 Socio-economic status, gender and early childhood self-regulation

Identifying the predictors of early childhood self-regulation problems was not a central aim of the current study. Nonetheless, examination of the relationships between the control variables and self-regulation indices yielded some interesting results. First, child gender was significantly related to some specific self-regulation indicators, but not all. Specifically, being a boy was associated with poorer sleep and emotional regulation in infancy, poorer emotional and cognitive regulation at 4-5 years old and better sleep regulation at 4-5 years old. Typically, studies find that girls tend to have less regulatory problems compared with boys (Gagne & Goldsmith, 2011; Hill et al., 2006; Sanson et al., 2009; Schmid et al., 2010), but some studies find no effects for gender (Colman et al., 2006; Degnan et al., 2008; Graziano et al., 2010; Zentall et al., 2012). The current study contributes additional evidence to the gender issues apparent in self-regulation by suggesting that there may be gender differences in specific aspects of self-regulation at specific times, but not at others. Future studies should investigate this hypothesis further.

Socio-economic disadvantage was also significantly related to some specific self-regulation indicators. Specifically, higher disadvantage was associated with poorer sleep regulation at 2-3 years and 4-5 years, poorer emotional regulation at 2-3 years and poorer cognitive regulation at 4-5 years. These findings concur with others who have found that children with poorer self-regulation are more likely to come from lower socio-economic environments (Degnan et al., 2008; Graziano et al., 2010).

Unexpectedly, socio-economic disadvantage was associated with slightly better emotional regulation during infancy and was not associated with sleep regulation at this time. Similarly, others have found socio-economic measures to not be associated with night-waking from 7 to 14 months (Zentall et al., 2012). It may be that the deleterious effects of disadvantage on child development had not had time to emerge at this stage. Some researchers have proposed a cognitive stimulation model to explain the relationship between socio-economic disadvantage and poorer self-regulation in children. This model suggests that more disadvantaged families may be less likely to invest in materials and experiences that stimulate children's learning (Chazan-Cohen et al., 2009; Linver, Brooks-Gunn, & Kohen, 2002) and that it is this lower level of a stimulating home environment that is associated with poorer self-regulation skills (McClelland, Morrison, & Holmes, 2000). In these types of environments children may have fewer opportunities to practice paying attention, or to practice emotional regulation with scaffolding from an engaged adult (Wanless, McClelland, Tominey, & Acock, 2011). Using this model, it might be expected that very early (infant) self-regulation skills have not yet been impacted on by family disadvantage, but later skills are. This hypothesis is somewhat confirmed by the findings of the current study. Others suggest a psychosocial stress model whereby the stressors associated with socio-economic disadvantage exert a deleterious effect on children's self-regulation development through biochemical effects on neurodevelopment and a negative impact on the types of parenting that supports development (Raver, Blair & Willoughby, 2013). Future research should seek to establish further evidence in regards to these theories.

Taken together, these findings confirm a number of other studies that identify socio-economic disadvantage as an important risk factor in relation to children's development of self-regulation. They suggest that in seeking to identify children at risk of a pathway of poor self-regulation development and later behavioural problems, practitioners should be particularly diligent when interacting with families experiencing socio-economic hardship. Future research that further explores the socio-economic gradient effect in relation to Australian children's self-regulation development is warranted.

5.5 Conclusion

The analyses presented in this chapter explored the relationship of children's self-regulation to later behavioural outcomes and maternal mental health over time. Evidence was found for the predictive validity of early mother-reported emotional and cognitive regulation in relation to behaviour problems during the early school years. Evidence was also found for both mother- and child-driven models that related maternal mental health to children's self-regulation and behavioural problems.

This study contributes to an understanding of self-regulation during infancy and early childhood in a number of ways. First, it reinforces the predictive validity of early self-regulation to related outcomes as found in many other prior studies. The brief mother-report measures used in this study when children were aged 2-3 years were predictive of both mother-reported and teacher-reported behaviour problems measured four years later. These findings support the validity of the measurement models developed in Study 1 and also point to the potential for these measures to be used as brief screeners in identifying children who may be at risk for poorer outcomes during the early school years.

Secondly, this study examined the bidirectional and longitudinal relationships between maternal mental health and children's self-regulation, an area of research which has been rarely addressed. Given the relatively high stability of maternal mental health symptoms across early childhood, mothers with a history of depression prior to giving birth are a clear risk group. They are more likely to have infants with self-regulation problems, and these children in turn are likely to exacerbate existing mental health problems for mothers. Additionally, mothers who report their child as having ongoing emotional regulation problems from 2-3 years, regardless of their prior mental health status, may also be a particular risk group given the child-driven effects evident from this age on.

In the final model, children's self-regulation was predictive of both mother-reported and teacher-reported behaviour problems at 6-7 years and in addition, mothers' early mental health predicted these problems as reported by mothers. However, effect sizes (path coefficients) were small indicating that many children with early self-regulation problems go on to have limited or no behaviour problems at school. In the next chapter, the research analyses examine the mechanisms by which this might occur through investigating the moderating and mediating effects of particular maternal parenting behaviours. Study 3 considers the relationship between children's self-regulation at age 2-3 years and child behavioural outcomes at age 6-7 years and whether this is moderated or mediated by maternal parenting measured at 4-5 years.

CHAPTER 6

STUDY 3: THE ROLE OF MATERNAL PARENTING AND MENTAL HEALTH IN THE RELATIONSHIP BETWEEN EARLY CHILDHOOD SELF-REGULATION AND LATER BEHAVIOURAL PROBLEMS IN CHILDREN.

6.1 Introduction

Study 3 explores the research question: Is the relationship between children's self-regulation during the third year and child behavioural outcomes in the seventh year moderated or mediated by maternal parenting and mental health measured in the fifth year? Many studies, including the analyses presented in Chapter 5, found that early child temperament and self-regulatory abilities are directly predictive of later behaviour problems (Kim & Deater-Deckard, 2011; Olson et al., 2011; Ramani et al., 2010). Transactional models of child development emphasise the complex role of the proximal environment of parenting in which early child development occurs. Research indicates that various parenting behaviours serve as risk or protective factors in relation to children's self-regulation development and the development of behaviour problems. The large majority of research focuses on maternal parenting and the current study will also do so. Overall, low maternal warmth, harsh discipline and high maternal control tend to be associated with poorer self-regulation skills (Graziano et al., 2010; Jennings et al., 2008; Olson et al., 2011) and the development of behaviour problems (Belsky et al., 1998).

Although direct effects are informative, research that seeks to address the transactional processes within the parent-child system must investigate the statistical interactions among child self-regulation and parenting constructs in relation to later outcomes. Studies of this type have relevance for early intervention and prevention programs. If particular aspects of parenting are consistently identified as key factors in the relationship between early regulation and later outcomes, this suggests these are the aspects of parenting that might be best targeted by support programs. Addressing these parenting behaviours might serve to minimise the risk of children with early self-regulation problems continuing to have behavioural problems after school entry.

In this study, maternal parenting behaviours and maternal mental health are tested as both moderators and mediators of the relationship between early self-regulation and later behaviour problems for children. Recent research on temperament, self-regulation, parenting and behaviour problems have variously positioned maternal parenting in a moderator role (Feng, Shaw, & Moilanen, 2011; Olsen et al., 2011), a mediator role (Whittaker, Harden, See, Meisch, & Westbrook, 2011), or both (Lorber & Egeland, 2011). A moderator variable is one that changes the strength or direction of a relationship between a predictor and outcome variable. In this study, if maternal parenting is found to be a moderator, this would imply that the strength of the relationship between self-regulation and behavioural outcomes changes as a function of different levels of particular maternal parenting behaviours. It was hypothesised that in the case of highly positive parenting, the relationship between self-regulation and behaviour problems would be very weak, but in the case of negative types of maternal parenting, the relationship would be strong.

Maternal parenting behaviours were also tested as mediators in this study. A mediator variable is one that acts as a third variable in a causal chain. In the model presented in Chapter 5, one maternal mediator effect emerged. The direct effect of reactivity at 2-3 years on mother-reported behaviour problems four years later was partially mediated by maternal mental health measured at 4-5 years. This leads to the question as to whether any other maternal parenting behaviours might mediate this relationship.

6.2 Data and Methods

These analyses are conducted with the same sample of 2880 LSAC Birth Cohort participants selected through the selection procedure outlined in Chapter 3 and used in the prior two studies. The previous study found both direct and indirect effects from the self-regulation aspects of reactivity and persistence at 2-3 years and behaviour problems four years later. The analyses presented in this chapter build on those findings by investigating the extent to which the relationship between self-regulation at 2-3 years and behaviour problems at 6-7 years is mediated or moderated by maternal parenting and mental health.

6.2.1 Measures used in the analyses

Wave 2 reactivity and persistence are the predictor variables in these analyses. Study 1 found that the measurement models for reactivity and persistence at 2-3 years had relatively strong fit to the data. It is important to recall that higher values on the reactivity latent variable reflect better emotional regulation due to the reversal of the scores. Sleep regulation was not directly predictive of later outcomes in the prior models and so sleep was not selected for use in this study. Details for the measurement models for the latent variables of reactivity and persistence are not repeated in this chapter. Readers are referred to Chapter 4 for these details.

The same control and outcome variables as were used in Study 2 (Chapter 5) were used again in this study. Control variables were history of maternal depression, child gender and socio-economic disadvantage (SED) all measured at Wave 1. Outcome variables were teacher-reported (SDQt) and mother-reported (SDQm) behavioural problems represented by the Total Problems Score of the *Strengths and Difficulties Questionnaire (SDQ;* Goodman, 2001) measured at Wave 4 when children were 6-7 years old.

Parenting measures

Parenting measures available from Wave 3 of LSAC (when children were aged 4-5 years) were selected for use in this study and were tested as both moderators and mediators. The decision to model parenting effects when children were aged 4-5 years (Wave 3) was because this represents the intervening time between the predictor variables (reactivity and persistence) measured at Wave 2, and the outcome variable (behavioural problems) measured at Wave 4. Selection was based on prior evidence that similar parenting constructs are significantly associated with children's developing self-regulation and behavioural problems across early childhood (Blandon, Calkins & Keane, 2010; Graziano et al., 2010; Olson et al., 2011). The selected constructs were maternal warmth, hostility, anger, inductive reasoning, consistency, self-efficacy and mental health. These were reported by mothers on self-complete surveys.

Warmth was assessed using six items from the *Child Rearing Questionnaire* (Paterson & Sanson, 1999). Mothers rated their expression of physical affection and enjoyment of the child on a 5-point scale (*never or almost never, rarely, sometimes,* *often, always or almost always*). *Hostility* was measured using adapted items from the Early Childhood Longitudinal Study of Children, Birth Cohort (National Center for Education Statistics, 2004) and the National Longitudinal Survey of Children and Youth 1998-1999 (Statistics Canada, 1999). Mothers responded to five items indicating hostile parenting behaviours such as losing their temper. The response scale was a 10-point semantic differential scale ranging from 1 = *not at all* to 10 = *all of the time. Anger* was measured using adapted items from the National Longitudinal Study of Children & Youth (Statistics Canada, 1999). Mothers rated their levels of anger during parenting tasks on five items using a 5-point scale (*never or almost never, rarely, sometimes, often, always or almost always*).

Inductive reasoning was measured using five items from the *Child Rearing Questionnaire* (Paterson & Sanson, 1999) on the extent to which mothers used reasoning when managing their children's behaviour. Each item was rated on a 5-point scale (*never or almost never, rarely, sometimes, often, always or almost always*). *Consistency* was measured using adapted items from the National Longitudinal Survey of Children and Youth 1998-1999 (Statistics Canada, 1999). Mothers responded to five items asking about the extent to which they followed through with behavioural consequences for children. Items were answered on a 10-point semantic differential scale ranging from 1 = *not at all* to 10 = *all of the time*.

Parenting self-efficacy was measured using items from the Early Childhood Longitudinal Study-Birth Cohort (National Center for Education Statistics, 2004). Mothers rated four statements related to feelings of self-efficacy in regards to parenting on a 5-point scale ranging from 1 = *never/almost never* to 5 = *always/almost always*. *Maternal mental health* was measured by the *Kessler K6* at each wave of data collection. The K6 consists of six items that ask about the respondents feelings over the past four-week period. Items are answered on a five-point scale ranging from 1 = *all of the time* to 5 = *none of the time* (Furukawa et al., 2003).

A composite measure of each of the parenting constructs (with the exception of maternal mental health; K6) was calculated using the proportionally adjusted factor score regression weights reported in Zubrick et al. (2013). These investigators used structural equation modelling (SEM) to assess items and scales used in the parenting measures included in LSAC. Well-fitting measurement models were then constructed and syntax was provided for the calculation of construct scores that take into account item loadings. Scores on the K6 screener were summed and averaged as is typically done and reflects the approach taken in Study 2.

6.2.2 Approach to the analyses

The analytic technique used in this study is longitudinal SEM. This allows the measurement models for the latent variables of reactivity and persistence to be estimated simultaneously with the regression equations that explain the relationship between these and the mediator, moderator and outcome variables. The use of the bootstrap method for testing indirect effects also provides additional confidence in any mediator effects found (MacKinnon, 2012).

Two types of analyses are undertaken in this study. The reason for this is that although maternal parenting and mental health have been shown to be related to children's self-regulation in various ways, clear conclusions about the effect of these in this area of study cannot yet be made. Some studies find no links between parenting style and children's self-regulation (e.g., Higgins, 2008) while others find no direct effects, but rather differential effects for children based on their self-regulation profile (e.g., Degnan et al., 2008). For these reasons it was considered worthwhile to conduct exploratory analyses that positioned maternal parenting behaviours and mental health as first moderators, and then as mediators in relation to early self-regulation and its influence on children's later behaviour problems.

Moderation

A moderator is a variable that influences the strength or direction of a relationship between a predictor and an outcome variable (Rose et al., 2004). Another term for moderation is interaction effects. These are tested by creating new variables that represent the interaction (products) terms of the predictor variables. First, the scores for the maternal parenting variables were centred by subtracting the mean in each case. This is conducted in order to avoid issues of multicollinearity in analyses. Then the latent variable predictors of reactivity and persistence were multiplied by each of the parenting scores using Mplus. This allows the measurement models for these latent variables to be estimated simultaneously with the creation of the interaction terms. Finally, separate analyses for each of the outcome variables (teacher- and mother-reported behavioural problems) regressed on to each of the predictor variables (reactivity and persistence), each parenting measure, and the associated interaction terms were run.

Mediation

Following the moderation analysis, a mediation analysis was conducted. A mediator is an explanatory link in the relationship between two other variables (MacKinnon, 2012). In this study, positioning aspects of maternal parenting as mediators between earlier self-regulation and later behavioural outcomes for children suggested the hypothesis that poor self-regulation in children *causes* more negative parenting behaviours which in turn *cause* behaviour problems in children. Given the child-driven effects established in Study 2 and the emergence of maternal mental health as a mediator of the relationship between children's reactivity and behavioural problems, pursuing this investigation was considered worthwhile. A mediation effect would be found if: a) maternal parenting was found to be significantly related to both a self-regulation measure and behaviour problems; and, b) the inclusion of parenting in the model significantly decreased (partial mediation) or ameliorated (full mediation) the direct effect of early self-regulation on later behaviour problems (Little, Card, Bovaird, Preacher, & Crandall, 2012). The significance of indirect (mediated) paths in SEM analyses is best tested by the bootstrap procedure (MacKinnon, 2012) as described in Chapter 3.

6.3 Results

In this section descriptive statistics and results from data screening are first presented. The results of three models are then presented in turn: direct effects of reactivity and persistence at 2-3 years on behavioural problems four years later; maternal parenting as a moderator of this relationship; and, maternal parenting as a mediator of this relationship. All analyses use SEM methodology and as in the previous studies, models include the control variables of child gender, SED and maternal history of depression.

Estimates are provided in the tables in both unstandardised and standardised forms. Only the relationships of substantive interest are shown in the figures in order to improve clarity for the reader. The measurement parts of the models that document the relationship of the latent variables of reactivity and persistence to their indicator variables is not replicated. The reader is referred to Chapter 4 for these results.

In the initial analysis of direct effects, no relationships between persistence at 2-3 years and any of the control variables were found and so these were not estimated in subsequent analyses. The relationship of reactivity at Wave 2 to the control variables was consistent with the findings from the previous studies. That is, being a boy, higher degrees of SED and a history of maternal depression were associated with poorer emotional regulation (reactivity) at 2-3 years. While these paths were estimated in the following models, results are not repeated here in the interest of brevity for the reader. Similarly, the relationship of the control variables with mother- and teacher-reported behaviour problems was consistent with previous findings (boys, SED and history of maternal depression were related to more behaviour problems) and thus while modelled in these analyses, results are not presented. Results for the effect of control variables are presented for the mediation model below, where for the first time, each of the parenting variables were regressed onto each of the control variables.

6.3.1 Descriptive statistics

All variables were examined for outliers and for signs of non-normality. Table 6.1 provides the bivariate correlations for pairs of continuous variables used in the current study along with their means, ranges and standard deviations. Histograms for these variables can be found in Appendix G. Most aspects of maternal parenting were significantly correlated with each other in the expected direction. The highest correlations were found for parenting anger and hostility (r = .580), anger and self-efficacy (r = -553), inductive reasoning and warmth (r = .483), and hostility and self-efficacy (r = - 455). Mother-reported behaviour problems were significantly correlated with each aspect of parenting though effect sizes were small to moderate. Teacher-reported behaviour problems were correlated with each measure of parenting except warmth and inductive reasoning. Again effect sizes were small. The latent variables of reactivity and persistence were also consistently and moderately correlated with the parenting measures. The correlation estimates were in the expected direction. That is, measures of positive maternal parenting were positively correlated with reactivity and persistence and negatively correlated with mother- and teacher-reported behaviour problems.

6.3.2 Direct effects

A natural first step prior to testing moderation and mediation models is to ascertain the direct relationships between the predictor and outcome variables. While this was done to some extent in Study 2 within the longitudinal panel model, simple direct paths from Wave 2 reactivity and persistence to later behaviour problems, without the inclusion of self-regulation measures at other time points had not yet been completed. The presence and strength of these direct effects need to be substantiated in order to assess the findings in the moderation and mediation models that follow.

A simple path model was estimated in which both teacher- and mother-reported behaviour problems were regressed onto both Wave 2 reactivity and Wave 2 persistence, while controlling for gender, SED and history of maternal depression. Reactivity and persistence were allowed to correlate with each other, as were teacher- and mother-reported behaviour problems. Consistent with the procedure in previous studies, non-significant paths related to the control variables were then trimmed. The trimmed model was a 'good' fit to the data (x^2 = 213.95, *df* = 52, *p* = .000, CFI = .984, TLI = .977, RMSEA = .033, WRMR = 1.210).

Teacher-reported behaviour problems were predicted by reactivity (β = -.119) and persistence (β = .042). This contrasts to the longitudinal model presented in Study 2 where Wave 2 persistence did not directly predict teacher-reported behaviour problems but did so indirectly through contributing variance to Wave 3 persistence which did predict teacher-reported behaviour problems. The direct effect in the current model was very small and it is likely that if Wave 3 persistence were included as it was in Study 2, it would fully mediate this effect. Given the small effect and the findings of Study 2 where this direct path did not emerge, it was decided to not include this path from Wave 2 persistence to teacher-reported behaviour problems in the models presented in the following sections. Mother-reported behaviour problems were predicted by reactivity (β = -.278) and persistence (β = -.224). The model accounted for 6.7% variance in teacher-reported behaviour problems and 19.5% of variance in mother-reported behaviour problems.

Table 6.1 *Bivariate correlations, means and SEs for parenting measures, reactivity, persistence and behavioural problems*

	1	2	3	4	5	6	7	8	9	10	11
1 Warmth	1										
2 Hostility	-.165*	1									
3 Anger	-.251*	.580*	1								
4 Inductive Reasoning	.483*	-.051*	-.068*	1							
5 Consistency	.130	-.272*	-.427*	.181*	1						
6 Self-efficacy	.281*	-.455*	-.553*	.176*	.374*	1					
7 Maternal mental health	-.088*	.236*	.251*	-.039*	-.179*	-.269*	1				
8 SDQm	-.108*	.294*	.369*	-.033*	-.209*	-.331*	.237*	1			
9 SDQt	-.017	.093*	.109*	.007	-.072*	-.133*	.061*	.425*	1		
10 Reactivity Wave 2 (LV)	.064*	-.367*	-.358*	.019	.212*	.305*	-.192*	-.332*	-.192*	1	
11 Persistence Wave 2 (LV)	.255*	-.172*	-.207*	.086*	.106*	.245*	-.113*	-.251*	-.057*	-.006	1
Range	2.56 – 4.99	1 – 10	1 – 5	1.53 – 5	2.33 – 5.89	1.84 – 5.18	0 – 4	0 - 31	0 – 35	LV	LV
Mean	4.53	3.1911	1.805	4.198	5.136	4.368	.512	7.676	5.219		
SE	.00866	.0242	.011	.01128	.012	.01187	.010	.0911	.095		

* Correlation is significant (*p* < .05). LV = latent variable. Correlation estimates for LVs provided by Mplus. SDQt = teacher-reported behaviour problems on the Total Problems Score of the *Strengths and Difficulties Questionnaire*. SDQm = mother-reported behaviour problems on the Total Problems Score of the Strengths and Difficulties Questionnaire

6.3.3 Moderation model

To test the hypothesised model presented in Figure 6.1, a series of 21 regression models were run. A separate model for each of the seven maternal parenting aspects in relation to each of the three significant direct paths (persistence to mother-reported behaviour problems, reactivity to mother-reported behaviour problems, reactivity to teacher-reported behaviour problems) was run. Testing moderation requires creating interaction terms between predictor variables (in this case the self-regulation variables and the parenting variables). As the self-regulation predictor variables in these models (reactivity and persistence) were a latent variable each time, the XWITH option in Mplus with TYPE = RANDOM was used. This process is computationally burdensome and so it was more practical to run the models separately in relation to each parenting aspect, rather than all at once. In each model, the measurement models for the latent self-regulation variables were estimated, along with the product of this latent variable and the centred parenting variable being examined. The outcome variable (behaviour problems) was then regressed onto the self-regulation latent variable, the centred parenting variable and the interaction term (self-regulation x parenting).

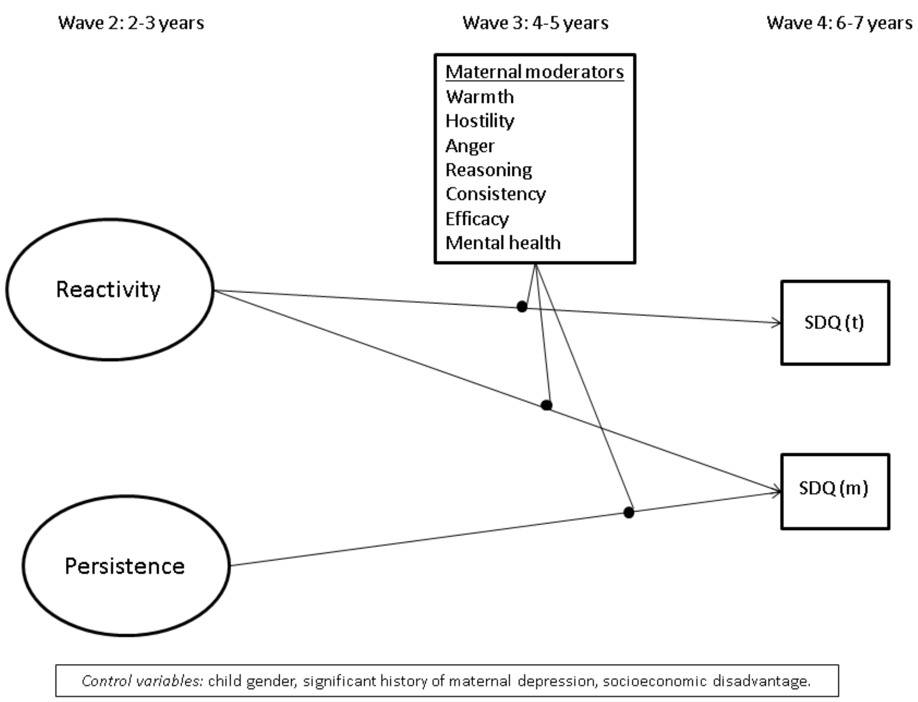

Figure 6.1. Hypothesised model for maternal parenting and mental health as moderators of early self-regulation in relation to behaviour problems.

A summary of results found in this series of regression analyses are displayed in Table 6.2. Standardised values are not provided by Mplus in the TYPE = RANDOM setting and so these are not provided in the table. As expected, the significant direct relationships between reactivity and persistence and mother- and teacher-reported behaviour problems found in the previous study were maintained in each model. Estimates varied very slightly between each model and thus only results from the first model estimation are shown. In addition, a number of significant direct relationships between aspects of maternal parenting at Wave 3 and behaviour problems at Wave 4 were found. Wave 3 parenting hostility, anger, consistency and self-efficacy were significantly associated with teacher-reported behaviour problems. Wave 3 parenting warmth, hostility, anger, consistency, self-efficacy and maternal mental health were significantly associated with mother-reported behaviour problems. Each of these relationships were in the expected direction with higher levels of more negative parenting aspects associated with higher levels of behaviour problems and more positive parenting associated with less behaviour problems. Results for these direct relationships between parenting and behaviour problems are found in the upper section of Table 6.2.

There was no evidence that the relationships between children's persistence and reactivity at 2-3 years and teacher- and mother-reported behaviour problems four years later were moderated by any aspect of parenting tested with one exception. This was evidenced by the lack of statistical significance for the regressions involving the interaction terms (self-regulation x parenting). The one exception was for the regression of mother-reported behaviour problems on the interaction term for persistence and self-efficacy which was statistically significant. This finding suggests a moderating role for parenting self-efficacy as reported by mothers.

To confirm this moderating effect, parameter estimates not provided by Mplus are required to probe the effect. Specifically, the mean and standard deviation of both predictor variables are required. As persistence was a latent variable in the initial analyses in Mplus, it has no mean or standard deviation. Therefore, this regression model was repeated in SPSS. Because standard regression modelling in SPSS does not allow for the use of latent variables, the summed and mean-centred score for reactivity was used. This involved summing the individual item scores for Wave 2 reactivity to create a composite, and then centering this variable. This is typically the way temperament measures such as reactivity are used (Sanson et al., 2009). The same mean-centred variable for self-efficacy was used and the interaction term was also created. The predictor variable and interaction term were checked for signs of multicollinearity but none were found. In this model the interaction term was no longer significant ($p = .051$).

This inconsistency in results between the two analysis programs suggests that this finding may be unstable. The lack of consensus between the models may be indicative of the measurement error present when using a composite score for reactivity in SPSS or there may have been issues of multicollinearity between the latent variable for reactivity and the other predictor variables in the Mplus analysis that were not immediately apparent. For the purposes of this study, this finding was considered too unstable to warrant further exploration, but future analyses should examine this further. An alternate approach to testing moderation effects is multi-group analysis where substantive models are compared across groups based on differing levels of the moderator variable. This approach could yield different results and should be pursued in future analyses.

Table 6.2 *Structural model estimates for the role of maternal parenting and mental health as moderators of early self-regulation in relation to behaviour problems*

	Teacher-reported behaviour problems (SDQt)		**Mother-reported behaviour problems (SDQm)**	
Parameter	**Unstandardised *(se)***	***p***	**Unstandardised (*se)***	***p***
Main effects				
Reactivity	-.222 (.049)	.000	-.469 (.047)	.000
Persistence	Not estimated		-.564 (.077)	.000
Warmth	-.283 (.216)	.190	-.736 (.189)	.000
Hostility	.187 (.086)	.029	.911 (.072)	.000
Anger	.526 (.195)	.007	.2.691 (.171)	.000
Reasoning	.052 (.154)	.736	.030 (.030)	.835
Consistency	-.361 (.166)	.030	-1.212 (.142)	.000
Self-efficacy	-.656 (.169)	.000	-2.005 (.159)	.000
Maternal mental health	.255 (.203)	.210	1.710 (.192)	.000
Moderated effects (interaction terms)				
Reactivity x Warmth	-.128 (.093)	.171	.017 (.049)	.848
Reactivity x Hostility	-.002 (.032)	.955	.007 (.034)	.827
Reactivity x Anger	-.013 (.067)	.851	.097 (.090)	.282
Reactivity x Reasoning	.006 (.081)	.944	.059 (.070)	.396
Reactivity x Consistency	-.054 (.070)	.440	-.127 (.069)	.067
Reactivity x Self-efficacy	.038 (.069)	.583	.110 (.072)	.128
Reactivity x Maternal mental health	.012 (.077)	.877	-.141 (.088)	.109
Persistence x Warmth	Not estimated		.150 (.145)	.301
Persistence x Hostility	Not estimated		-.622 (.054)	.128
Persistence x Anger	Not estimated		-.250 (.137)	.069
Persistence x Reasoning	Not estimated		.119 (.106)	.259
Persistence x Consistency	Not estimated		.041 (.113)	.714
Persistence x Self-efficacy	Not estimated		.268 (.122)	.028
Persistence x Maternal mental health	Not estimated		-.119 (.180)	.511

6.3.4 Mediation model

To test the hypothesised model shown in Figure 6.2 below, a fully saturated model was first estimated, with each of the variables controlled for the effects of child gender, SED and a significant history of maternal depression. All possible regression paths between the outcome, parenting and self-regulation latent variables were included.

This model was run with all maternal parenting and mental health measures included simultaneously and allowed to correlate with each other. Non-significant paths related to the control variables were then trimmed. There were no significant relationships between maternal consistency, reasoning, parenting warmth or child persistence and any of the control variables. Maternal parenting hostility and mental health were not significantly associated with SED or child gender. Finally, maternal efficacy was not significantly related to child gender.

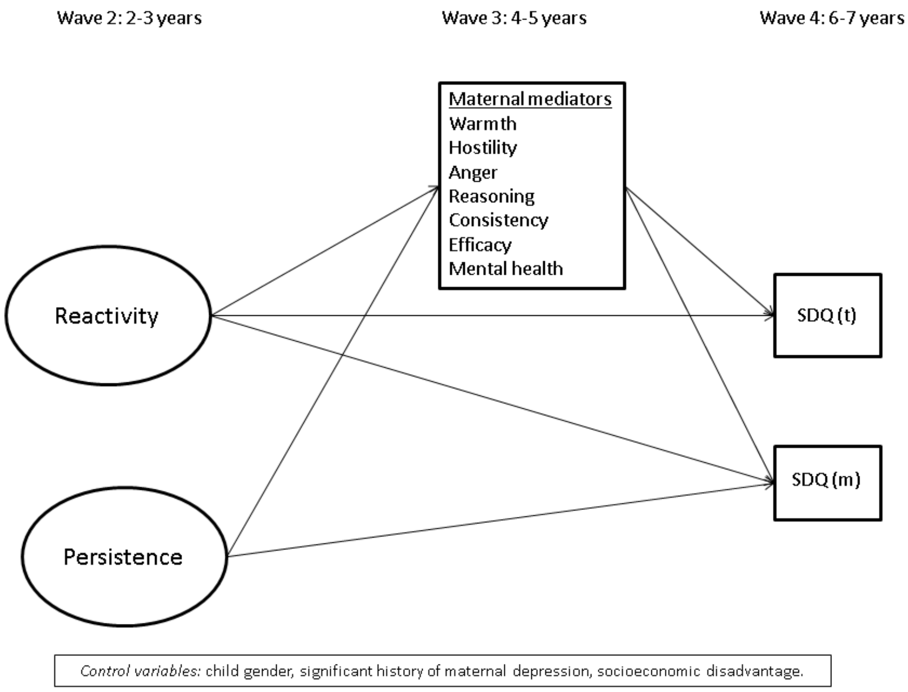

Figure 6.2. Hypothesised model for maternal parenting and mental health as mediators of early self-regulation in relation to behaviour problems

The trimmed model was a ‘good’ fit to the data (x^2 = 331.149, *df* = 105, *p* = .000, CFI = .985, TLI = .973, RMSEA = .027, WRMR = 1.020). There were no large modification indices that made substantive sense and so this model was accepted as the final model. Because the direct effect regression model presented in Section 6.3.2 was not nested in the current mediation model it was not possible to statistically test for differences between the two in model fit. Examination of the fit indices makes it apparent that the models fit the data approximately equally well. However, the mediation model which included maternal parenting accounted for additional variance over and above that accounted for by the direct effects models presented in Section

6.3.2. The mediation model accounted for 7.3% of variance in teacher-reported behaviour problems compared to 6.7% for the direct effects model. The mediation model accounted for 25.9% of variance in mother-reported behaviour problems compared to 19.5% for the direct effects model. Unstandardised and standardised estimates for each path in the model are found in Table 6.3.

Direct effects were found for Wave 2 reactivity in relation to mother- (β = -.174) and teacher-reported behaviour problems (β = -.094) and Wave 2 persistence in relation to mother-reported behaviour problems (β = -.169). These confirm the findings in Study 2 and represent decreased direct effect sizes from those presented in Section 6.3.2 above, as would be expected in mediation models. Direct effects were also found in relation to the parenting aspects. Maternal parenting anger, self-efficacy and mental health as measured at Wave 3 significantly predicted mother-reported behaviour problems two years later. Only self-efficacy predicted teacher-reported behaviour problems. These relationships were all in the expected direction. Higher mother-reported behaviour problems were predicted by higher maternal parenting anger (β = .166), lower levels of maternal self-efficacy (β = -.086) and higher symptoms of psychological distress in mothers (β = .089). Mothers who reported feeling more efficacious as parents also had children with fewer teacher-reported behaviour problems (β = -.071).

Most aspects of parenting at Wave 3 were consistently and relatively strongly predicted by children's reactivity and persistence at Wave 2. Higher levels of emotional regulation as measured by reactivity were associated with higher levels of maternal parenting warmth (β = .051), lower parenting hostility (β = -.349), lower parenting anger (β = -.334), higher consistency (β = .182), higher self-efficacy (β =.270) and fewer symptoms of psychological distress in mothers (β = -.156). Higher levels of persistence in children at Wave 2 were associated with higher levels of parenting warmth (β = .249), lower hostility (β = -.141), lower anger (β = -.176), higher levels of inductive reasoning (β = .192), higher maternal self-efficacy (β = .222) and fewer symptoms of psychological distress (β = -.097).

In regards to the control variables and their relationship to the parenting aspects, higher SED was associated with more warm mothers (β = .060) and lower levels of reasoning (β = -.045), consistency (β = -.137) and self-efficacy (β = -.072). A history of maternal depression was significantly associated with higher levels of parenting hostility (β = .116), parenting anger (β = .144) and psychological distress (β = .801) and lower levels of self-efficacy in mothers (β = .132). Male children were more likely to have more mothers who reported higher levels of parenting anger (β = .067).

Evidence for the hypothesised mediated pathways was found only in relation to maternal self-efficacy, mental health and parenting anger. These measures of parenting met the requirements for mediation in that they were each significantly associated with the predictors and the outcome variables, and their inclusion in the model reduced the strength of the direct associations between the predictors and the outcome variables. To test the significance of these indirect pathways, the model was run again using the bootstrap procedure as recommended by MacKinnon (2012) and significance of these paths was confirmed. The estimates for the significant mediated pathways (total effects) are found in the final section of Table 6.2. The relationship between persistence and mother-reported behaviour problems was partially mediated by maternal self-efficacy, mental health and parenting anger. Maternal self-efficacy also acted as a mediator between reactivity and mother- and teacher-reported behaviour problems. Figure 6.3 provides the standardised estimates for the significant paths in the substantive part of the model only. In the interests of clarity for the reader, the paths associated with the control variables are not shown in the figure, but estimates for the relationships between the control variables and the parenting variables can be found in Table 6.2.

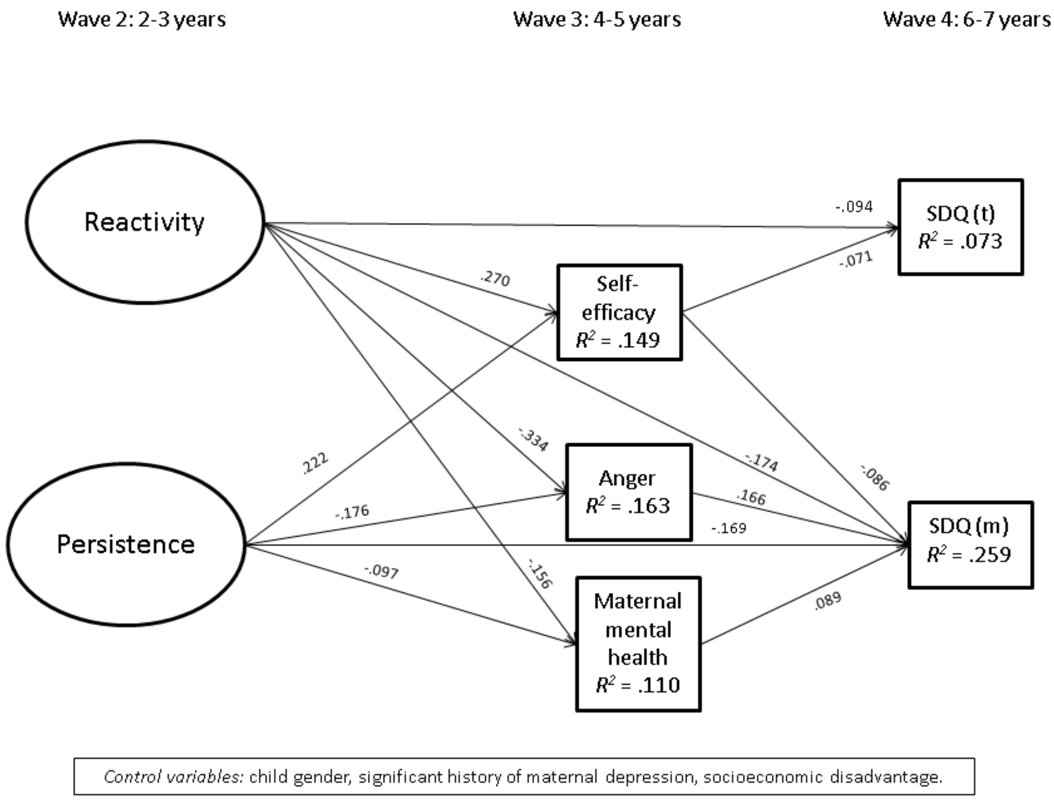

Figure 6.3. Final model for maternal parenting and mental health as mediators of early self-regulation in relation to behaviour problems. All estimates are standardised. Non-significant paths are not shown. Higher scores on reactivity reflect a higher degree of emotional self-regulation. Fit statistics: x^2 = 331.149, *df* = 105, *p* = .000, CFI = .985, TLI = .973, RMSEA = .027 (CI .026 - .029), WRMR = 1.020.

Table 6.3 *Structural model estimates for the role of maternal parenting and mental health as mediators of early self-regulation in relation to behaviour problems*

Parameter	Unstandardised *(se)*	Standardised	*p*
Direct effects related to teacher-reported behaviour problems			
Reactivity Wave 2 → SDQt	-.383 (.095)	-.094	.000
Persistence Wave 2 → SDQt	-.158 (.130)	-.029	.224
Warmth → SDQt	.049 (.240)	.004	.838
Hostility → SDQt	.005 (.099)	.001	.958
Anger → SDQt	.077 (.234)	.009	.742
Reasoning → SDQt	.197 (.184)	.023	.284
Consistency → SDQt	-.068 (.180)	-.008	.707
Self-efficacy → SDQt	-.574 (.201)	-.071	.004
Maternal mental health → SDQt	-.004 (.202)	.000	.983
Direct effects related to mother-reported behaviour problems			
Reactivity Wave 2 → SDQm	-.678 (.089)	-.174	.000
Persistence Wave 2 → SDQm	-.888 (.125)	-.169	.000
Warmth → SDQm	.072 (.213)	.007	.734
Hostility → SDQm	.112 (.081)	.030	.168
Anger → SDQm	1.425 (.230)	.166	.000
Reasoning → SDQm	.213 (.156)	.026	.172
Consistency → SDQm	-.066 (.148)	-.009	.656
Self-efficacy → SDQm	-.664 (.175)	-.086	.000
Maternal mental health → SDQm	.820 (.187)	.089	.000
Direct effects related to parenting aspects			
Reactivity → Warmth	.019 (.008)	.051	.022
Reactivity → Hostility	-.362 (.027)	-.349	.000
Reactivity → Anger	-.152 (.013)	-.334	.000
Reactivity → Reasoning	-.020 (.011)	-.041	.068
Reactivity → Consistency	.093 (.012)	.182	.000
Reactivity → Self-efficacy	.137 (.013)	.270	.000
Reactivity → Maternal mental health	-.066 (.010)	-.156	.000
Persistence → Warmth	.124 (.013)	.249	.000
Persistence → Hostility	-.197 (.031)	-.141	.000
Persistence → Anger	-.107 (.014)	-.176	.000
Persistence → Reasoning	.124 (.016)	.192	.000
Persistence → Consistency	.064 (.016)	.094	.000
Persistence → Self-efficacy	.151 (.016)	.222	.000
Persistence → Maternal mental health	-.055 (.012)	-.097	.000
Control variables related to parenting			
SED → Warmth	.029 (.009)	.060	.002
SED → Reasoning	-.028 (.012)	-.045	.016
SED → Consistency	-.091 (.014)	-.137	.000
SED → Self-efficacy	-.048 (.012)	-.072	.000
Gender (male) → Anger	.038 (.019)	.0668	.041
History of maternal depression → Hostility	.151 (.071)	.116	.034
History of maternal depression → Anger	.082 (.032)	.144	.011
History of maternal depression → Self-efficacy	-.084 (.038)	-.132	.025
History of maternal depression → Maternal mental health	.411 (.038)	.801	.000
Significant mediated effects			
Reactivity → Self-efficacy → SDQt	-.079 (.029)	-.019	.007
Reactivity → Self-efficacy → SDQm	-.091 (.026)	-.023	.000
Reactivity → Anger → SDQm	-.216 (.037)	-.055	.000
Reactivity → Maternal mental health → SDQm	-.054 (.015)	-.014	.000
Persistence → Self-efficacy → SDQm	-.100 (.028)	-.019	.000
Persistence → Anger → SDQm	-.153 (.033)	-.029	.000
Persistence → Maternal mental health → SDQm	-.045 (.014)	-.009	.001

6.4 Discussion

This study explored the research question: Is the relationship between children's self-regulation during the third year and child behavioural outcomes in the seventh year moderated or mediated by aspects of maternal parenting and mental health measured in the fifth year? The results of the previous studies led to the selection of children's reactivity and persistence measured at 2-3 years of age as the predictors in these analyses. Seven aspects of parenting measured two years later by mother report were selected and tested as first moderators and then mediators of the relationship between reactivity and persistence and children's behaviour problems at age 6-7 years as reported by teachers and mothers. While many studies find more positive parenting to be associated with positive outcomes for children, the body of research examining parenting and self-regulation is more mixed. Some studies find no (Higgins, 2008), or differential effects, depending on the interactions of child temperament with various parenting aspects (Degnan et al., 2008). This study therefore took an exploratory approach by including seven measures related to maternal parenting and mental health, and testing them as both moderators and mediators.

Contrary to the hypothesis, none of the parenting variables were substantiated as moderators of the relationship between early self-regulation and later behavioural problems for children. It was anticipated that highly positive maternal parenting as exhibited through high warmth and low anger and hostility would weaken or even ameliorate the predictive value of early self-regulation in relation to later behavioural problems. This was not the case in this study. This hypothesis was developed through the evaluation of previous studies including one by Healey and colleagues (2011) who found positive parenting to moderate the relationship between attentional and hyperactivity symptoms in children and their clinician-rated functioning (Healey, Flory, Miller, & Halperin, 2011). These researchers used cross-sectional data for an at risk population of preschoolers that exhibited high levels of cognitive and behavioural self-regulation problems.

It is possible that in the current study, the temporal distance between the predictor, moderator and outcome variables which were each measured two years apart precluded the finding of any effects. Different results may have been found if cross-sectional data were used in the moderation analysis and this should be pursued in future studies. In addition, the current study used a normative population sample. Different results may have been found for an at risk sample and this too should be pursued in future work. Finally, the selection of analysis methodology whereby interaction terms were created may have influenced results. An alternative method would have been to conduct multi-group analysis with two or more groups created on the basis of more positive or more negative parenting attributes. Again, this could be pursued in future investigations.

Three aspects of parenting were found to mediate the relationships between early self-regulation and later behaviour problems for children: maternal mental health, parenting anger and maternal self-efficacy. Broadly stated, higher early childhood emotional and cognitive regulation (as measured by reactivity and persistence), was associated with higher maternal self-efficacy, lower levels of parenting anger and better maternal mental health which in turn were associated with less behaviour problems. Other studies have also had similar findings. For example, parenting behaviours such as rejection, warmth and autonomy support have been found to mediate the relationship between children's negative emotionality and internalising problems both cross-sectionally (Paulussen-Hoogeboom, Stams, Hermanns, Peetsma, & van den Wittenboer, 2008) and longitudinally (Van der Bruggen, Stams, Bogels, & Paulussen-Hoogeboom, 2010).

Of particular interest in the current study is the consistent role of maternal self-efficacy as a mediator. Maternal self-efficacy consistently mediated the relationship between early self-regulation and mother-reported behaviour problems and was the only parenting aspect found to act as a mediator in relation to teacher-reported behaviour problems. This may be considered a reasonably robust finding given that teacher-reported behaviour problems are free from the response bias potentially present in the other mediated pathways due to the same informant (the mother) being used across time and across the self-regulation, parenting and outcome measures.

The identification of parenting self-efficacy as a key mediator between early self-regulation problems and later behaviour problems for children appears to be a relatively unique finding, not previously explored. Maternal self-efficacy has been found by others to mediate the relationship between prenatal stress and infant crying

(Bolten et al., 2012), between child behaviour and later parental behaviour (Meunier, Roskan, & Browne, 2011) and between difficult child temperament and parental involvement in home learning activities (Giallo, Treyvaud, Cooklin, & Wade, 2013). The findings in the current study somewhat reflect those by Giallo and colleagues (2013) who found that children with more difficult temperaments had parents who negatively appraised their parenting ability. In the current study children who exhibited self-regulation problems contributed to poorer maternal self-efficacy two years later. In Giallo's study lower levels of parental self-efficacy then went on to predict less time spent in parent-child learning activities. It may be that in the current study, poorer maternal self-efficacy contributed to mothers 'giving up' on positive parenting practices over time, which in turn contributed to the increased risk of later behavioural problems for children. Taken together, these findings suggest that future research might consider maternal parental self-efficacy as a mediating variable in a more complex causal chain whereby child self-regulation predicts parental self-efficacy which predicts parental behaviours which predict the development of behaviour problems in children.

A substantial limitation of the mediational model in this study is the fact that prior levels of parenting were not controlled for, weakening the interpretation that children's self-regulation had a causal effect on parenting which then had a causal effect on behaviour problems. True longitudinal mediation models control for prior levels of all variables across two or more waves of data (MacKinnon, 2012). Further, the bidirectional relationships among the parenting aspects and self-regulation across multiple waves of data were not explored and should be the focus of future studies. Study 2 found evidence for both mother- and child-driven effects in relation to maternal mental health only. It is likely that these bidirectional effects will also be present for a number of other aspects of parenting (e.g., Verhoeven, Junger, van Aken, Dekovic, & van Aken, 2010). Multi-wave longitudinal panel models similar to that documented in Study 2 that include repeated measures of parenting and children's self-regulation would better elucidate the role of each variable.

Future studies should also explore alternative and more complex models for the role of maternal parenting in the developmental pathway involving self-regulation. For example, Healy and colleagues (2011) found that child temperament contributed to parenting stress which then significantly influenced negative parenting. Negative parenting (but not stress) then acted as the moderator in the relationship between child hyperactivity symptoms and functioning. In the current study, only three of the seven parenting measures tested played mediating roles and none played moderating roles. Alternative models could consider maternal characteristics such as mental health and self-efficacy as predictors of maternal parenting behaviours such as anger, hostility and consistency. Again, cross-lagged bidirectional longitudinal panel models would be useful in understanding the mechanisms within the parent-child system in a more nuanced way.

6.5 Conclusion

The analyses presented in this chapter explored the extent to which maternal parenting and mental health play a role in the relationship between children's early self-regulation (measured at 2-3 years) and later behavioural outcomes (measured at 6-7 years). Contrary to hypotheses, none of the parenting variables were found to play a moderating role. Self-efficacy, parenting hostility and maternal mental health did partially mediate the relationship between early self-regulation and behaviour problems four years later. Better emotional and cognitive regulation in children contributed to higher self-efficacy in mothers, lower levels of parenting anger and fewer symptoms of psychological distress which in turn predicted fewer mother-reported behaviour problems. In addition, higher maternal self-efficacy also predicted fewer teacher-reported behaviour problems.

This study contributes additional empirical evidence to transactional models of child development. Importantly, it also identifies the aspects of maternal parenting that might be most salient in terms of buffering children with poor self-regulation skills against the risk of developing behaviour problems in the early school years. Specifically, the findings suggest that parenting support during early childhood that aims to improve parenting self-efficacy and mental health and reduce parenting anger and hostility will have a positive impact for these children.

This study is considered highly exploratory in nature and is limited by a number of issues. These include the failure to control for prior levels of maternal parenting and the lack of exploration of reciprocal relationships in the mother-child system over time. The sources of model misfit in the measurement models for reactivity and persistence also contributed to misfit in the mediation models. Shared method variance is also an important consideration given that mothers reported children's self-regulation, their own parenting and mental health and children's outcomes. Nonetheless the study does represent an improvement on studies that use purely cross-sectional data by including measures across three time points from age 2 to 7 years. The inclusion of teacher-report data strengthens the analyses in relation to concerns about shared method variance. The continued modelling of measurement error through the latent variable measurement models, while compromising model fit, represents a methodological strength of the analyses.

Study 4 takes a departure from the variable-centred approach taken to date in this thesis. It uses a person-centred approach to address the research question: *What are the profiles of self-regulation in children aged birth to 5 and how are they related to child outcomes and parenting?* Longitudinal latent profile analysis using the same self-regulation indicators used in the prior three studies allows for the exploration of pathways of self-regulation development in this sample of Australian children. The hypothesis that there will be a single normative pathway along with one or more non-normative pathways of self-regulation development is tested. Differences between these groups on early school behaviour problems and maternal parenting and mental health are then explored using descriptive statistics and path analyses.

CHAPTER 7

STUDY 4: LONGITUDINAL PROFILES OF SELF-REGULATION ACROSS THE FIRST FIVE YEARS AND THEIR RELATIONSHIP TO PARENTING AND BEHAVIOURAL OUTCOMES

7.1 Introduction

Study 4 explores the research question: What are the profiles of self-regulation in children aged birth to 5 and how are they related to child outcomes and parenting? Very little is known about the normative pattern of sleep, emotional and cognitive regulation development in Australian children across the first five years of life. In this study, a person-centred approach is taken to address this question. This allows for the normative pattern of self-regulation development to be established, despite the fact that the measures for self-regulation change across this period of rapid growth and development. In turn, this study also identifies the key indicators of a departure from this normative pattern and tests the extent to which early childhood self-regulation profile membership predicts later behaviour problems.

It is likely that children who are members of profiles that do not follow the normative pathway of self-regulation development will be at greater risk of developing later behavioural problems. It is therefore important to establish the early indicators of these pathways such that children who are most likely to continue to struggle with self-regulation can be identified early. Early identification is a key issue to providing additional supports that might act to improve children's self-regulation and, therefore, minimise the risk of future behaviour problems. This study makes a significant contribution by establishing both the normative and non-normative patterns of self-regulation development and documenting the key indicators of such.

The study also explores the ways in which early childhood self-regulation profile membership is related to maternal parenting and maternal mental health. In line with the preceding two studies presented in this thesis, it is expected that patterns of non-normative self-regulation development in children will be associated with poorer maternal mental health, more negative parenting practices and less positive parenting practices. The findings of this study will contribute to identifying the ways in which the early parenting environment provides a buffer for children with self-regulation problems. Empirical evidence such as this is important in informing the goals and directions of early parenting supports that aim to build capacity in parents in the areas that make the most significant contributions to positive child development.

Study 4 presents a person-centred approach in the examination of self-regulation. The reasons for this are two-fold. First, the prior studies presented in this thesis have taken a variable-centred approach where it was assumed that associations found held for each individual within the research population. In particular, the confirmatory factor analyses (CFAs) in Study 1 assumed that the relationships between the self-regulation measures existed in the same form and strength for each case in the dataset. The person-centred approach selected for Study 4 tests this assumption and hypothesises that, in fact, the population is heterogeneous in respect to the relationships between variables; particularly that different profiles of self-regulation can be identified over time.

The second reason to take a person-centred approach relates to the examination of self-regulation across early childhood. Because the measures established in Study 1 were not in any way invariant across time, analyses that examined growth or change longitudinally were not possible. In order to gain insight into the ways in which self-regulation develops from birth to 5 in this study, a person-centred methodology that allows for the establishment of longitudinal typologies of behaviour was selected. The variable- and person-centred approaches are considered complementary as each approach provides unique information about the ways in which self-regulation can be understood in early childhood. Study 4 is concerned with the hypothesis that children will differ in their profiles of self-regulation over time as reflected by the measured indicators and that these profiles will differ in relation to maternal parenting and later outcomes for children.

7.2 Data and Methods

These analyses are conducted with the same sample of 2880 LSAC Birth Cohort participants selected through the selection procedure outlined in Chapter 3 and used in the previous three studies. Latent profile analysis (LPA) was conducted to describe the longitudinal typologies of self-regulation development in the sample. Further details on LPA are provided in Chapter 3. The relationship of profile membership to later behaviour problems is then explored using path analysis. The extent to which the relationship between profile membership and later behaviour problems is mediated by parenting is also investigated.

7.2.1 Measures used in the analyses

Mother report of sleep problems, reactivity and persistence at three time points from infancy to 5 years are used as indices of self-regulation. These are the same items as used in the prior studies in this thesis and further details can be found in Chapter 4. The control, outcome and parenting variables were the same as those used in the analyses reported in Chapters 5 and 6. Gender, socio-economic disadvantage (SED) and history of maternal depression were the control variables; teacher- and mother-reported behaviour problems on the Total Problems Score of the *Strengths and Difficulties Questionnaire* (SDQ) were the outcome variables; and parenting variables were maternal warmth, hostility, anger, inductive reasoning, consistency, self-efficacy and mental health. These were reported by mothers on self-complete surveys.

7.2.2 Approach to the analyses

A number of options were considered in relation to how the dependent variables (indicators of self-regulation) would be represented in the latent profile models. One option considered was to use the factor score of the latent variables (sleep, reactivity and persistence) that were established in Study 1. These factors scores are able to be calculated in Mplus and would take into account the ways in which the indicator variables loaded in different patterns in each measurement model. However, the measurement models did not perfectly fit the data and the amount of variance accounted for by the latent variables was only moderate. The use of factor scores also leads to concerns regarding factor indeterminacy.

Instead, the raw indicator variables were summed and averaged and scale scores were created for the items measuring sleep regulation, reactivity and persistence. Temperament subscales are commonly used in this manner (Sanson et al., 2009). Given the robustness of the scale measuring sleep regulation over time identified in Study 1, it was considered appropriate to also create a composite scale from these items for sleep regulation. Standardising the scores was also considered, as having scores on the same scale can assist with model convergence. However, where convergence is not a problem, the use of raw scores is recommended due to the fact that using raw scores allows the covariance matrix to be used as input rather than a correlation matrix (Muthén, 2007), resulting in more trustworthy results.

Linear growth trajectories were not possible due to the changing nature of the measurement of self-regulation over early childhood in this study, thus the classes established in the analyses are referred to as longitudinal profiles, rather than trajectories. Estimation in Mplus is achieved using the maximum likelihood estimator which iteratively calculates model parameters that are most likely to account for the observed data. A posterior probability of profile membership for each latent profile is then calculated and individuals can be assigned a latent profile for which their posterior probability is highest (Muthén, 2004).

Selection of the optimal number of profiles was based on a range of criteria. Four measures of relative model fit (compared to the same model with one less profile) were used including the Bayesian Information Criterion (BIC; Schwarz, 1978) and the Consistent Akaike's Information Criterion (CAIC; Bozdogan, 1987). For both of these indices, the lowest value indicates the "best" model. The Lo-Mendell-Rubin (LMR) test (Lo et al., 2001) and the bootstrapped likelihood ratio test (BLRT; McLachlan & Peel, 2000) signal the "best" model as the one with the smallest number of profiles that is not significantly improved by the addition of another profile.

Along with these measures of model fit, it is also recommended that researchers carefully consider the profile sizes, the substantive meaning and value of the resulting profiles and the ability of the latent profiles to correctly classify individuals (Collins & Lanza, 2010). In the current study it was decided that a profile resulting in likely membership of fewer than 100 cases (3.5% of the current sample) would be limited in its applicability to real world settings and of little utility in ongoing analyses of profile predictors and outcomes. It was recognised that to have practical applicability in terms of identifying children at risk of poorer outcomes, the latent profile variable needed to be able to strongly differentiate children with more problematic self-regulation profiles from those with consistently positive self-regulation profiles. Statistical indicators to be examined were the relative entropy of the model, that is, the extent to which there was a lack of error in classifying individuals into their respective profiles (higher values indicate less error), and the average posterior probabilities of profile membership (on a scale of zero to one with higher scores preferred; Collins & Lanza, 2010).

In the path analyses that follow the LPA, latent profile membership was treated as an ordinal categorical variable with higher scores indicating membership of the more poor regulation profiles. The WLSMV estimator was selected to take account of this ordinal variable. An assumption required for path analysis estimation in SEM software when using this estimator, is that any mediating ordinal categorical variables within the model (that is, a variable that is both dependent and independent), represent an underlying continuous latent variable. The profile variable in these analyses is both a dependent and independent variable due to the use of control variables as predictors of the profile variable and the profile variable predicting outcomes. It is considered reasonable to assume that the ordinal manifest variable of profile membership, represents an underlying continuous latent variable with higher scores indicating more problems with self-regulation (more likely membership of the poorer profiles), and lower scores indicating less problems (more likely membership of the normative profile). It is this underlying continuous latent variable that is used in the estimation of the path model within the Mplus software and so the variable is termed self-regulation problems.

7.3 Results

In this section descriptive statistics and results from data screening are first presented. The results of the latent profile analysis are then presented in Section 7.3.2. The ability of profile membership to predict later behavioural problems and maternal mental health is then examined using first descriptive statistics (ANOVA and chi-square) and then path analysis (Section 7.3.3). As well as examining profile differences in relation to the SDQ Total Problems Score, profiles were examined for differences on the proportion of children in each who fell into the broadband and clinical cut-off scores for this score. Results on the Total Problems Score are categorised as normal (79th percentile or below), borderline (80th to 89th percentile), or clinical (more than or equal to the 90th percentile; Goodman, 2001). Therefore the broadband range could be considered to be all of those scores above or equal to the 80th percentile (those in the borderline and clinical ranges).

The results of the path analyses that investigate the direct effects of profile membership on later behavioural problems and maternal mental health, and the extent to which these effects are mediated by maternal parenting are then presented. In this study, positioning maternal parenting and mental health as mediators between earlier childhood self-regulation problems (as measured by profile membership) and later behavioural outcomes for children suggests the hypothesis that poor self-regulation in children *causes* more negative parenting behaviours which in turn *causes* behaviour problems in children. The results of Study 3 substantiated this hypothesis and found that maternal mental health, parenting anger and hostility mediated the effect of reactivity and persistence in toddlerhood on behaviour problems at 6-7 years. A similar analysis conducted as part of this study, using the latent profile variable as the predictor, would provide additional evidence for these effects and would explore them in the context of consistent longer term self-regulation problems in the early years.

7.3.1 Descriptive statistics

Descriptive statistics for the scale scores for sleep regulation (sleep), reactivity (react) and persistence (persist) along with bivariate correlations are shown in Table 7.1. Histograms showing the distributions of the scale scores are presented in Appendix G. Each of these scale scores were screened for normality and were found to fall within the recommended range for SEM analysis (Kline, 2011).

Table 7.1 *Bivariate correlations and descriptive statistics for self-regulation scale scores across three waves*

	1	2	3	4	5	6	7	8
1 Sleep 1								
2 Sleep 2	.292*							
3 Sleep 3	.231*	.441*						
4 React 1	.317*	.167*	.112*					
5 React 2	.113*	.136*	.122*	.171*				
6 React 3	.083*	.153*	.185*	.185*	.385*			
7 Persist 2	.039*	.092*	.055*	.171*	.058*	.193*		
8 Persist 3	.008*	.080*	.116*	.120*	.161*	.244*	.332*	1
Range	0 - 4	0 - 4	0 - 4	1 - 6	1 – 6	1 – 6	1 - 6	1 – 6
Mean	3.3	3.27	3.53	4.49	4.04	4.43	4.34	3.89
SE	.016	.019	.016	.015	.017	.016	.014	.016
Reliability (Cronbach's alpha)	.468	.566	.566	.580	.756	.678	.700	.787

* p < .05

7.3.2 Latent profile analysis

Model comparisons

Latent profile models with one, two, three and four profiles were fitted to determine the most parsimonious number of profiles to describe self-regulation from birth to 5 years in the LSAC sample. Fit indices as described in Section 7.2.2 were recorded. The model with four profiles was not identified and so models with more than four profiles were not tested. Results are presented in Table 7.2. The three profile solution had the lowest BIC and highest entropy. It also had an acceptable number of members per profile with the smallest profile representing 4% of the sample (*n* = 112).

The average posterior probabilities indicate the degree to which individuals are likely to have been correctly classified within each profile. Posterior probabilities in these analyses ranged from .998 to one, allowing a very high degree of confidence in profile assignment. As shown in Table 7.3 below, Profile 1 and Profile 3 perfectly predicted membership. A small .02% of Profile 2 (or 15 cases) had the chance of being incorrectly classified.

Table 7.2 *Model fit information for the latent profile analysis*

Number of profiles	**Log-likelihood**	**Number of parameters**	**Entropy**	**BIC**	**AIC**	**LMR *p*-value**	**BLRT *p*-value**
1	-29215	16	1.00	58558	58463	NA	NA
2	-28105	25	0.959	56409	56260	.000	.000
3	-27371	34	0.997	55013	54810	.000	.000
4	Unidentified						

Table 7.3 *Average latent profile probabilities for most likely latent profile membership (row) by latent profile (column)*

	1	2	3
1	99.8%	0	.02%
2	0	100%	0
3	0	0	100%

Profile probabilities were saved in Mplus and then exported to SPSS where simple data screening and diagnostics were conducted. The three profiles were examined separately for outliers, skewness and kurtosis in relation to the indicator variables. There were no consistent outliers shown in box plots and none of the variables within each profile had skewness or kurtosis scores outside of the recommended range for further use within the SEM analysis framework (Kline, 2011). The model with three latent profiles was therefore accepted as the final model. Descriptive statistics and histograms showing scale score distributions for each profile are provided in Appendix H.

Description of the longitudinal profiles

Mean scores for the sleep, reactivity and persistence scales for each profile at each wave are presented in Table 7.4. In order to assist in the graphical presentation and further interpretation of the results, these scores were then standardised. Figure 7.1 provides the graphical representation of the profiles using these standardised scores. ANOVAs were conducted to establish the extent to which each profile was distinguished from the other profiles on each of the indicator scales used.

The most likely profile membership for this sample was in Profile 1 (69%, *n* = 1989) and so this was labelled the *normative* profile for self-regulation. This profile was characterised by consistently higher scores on each self-regulation indicator at each wave, compared to the subsequent poorer self-regulation profiles. Sleep regulation scores improved over the waves for this profile, with 100% of profile members scoring a perfect sleep regulation score (that is a lack of sleeping problems) at Wave 3 (4-5 years). This normative profile was distinct from the other two profiles on each indicator variable at each wave.

Table 7.4 *Profile means and standard errors for the self-regulation scales*

	Profile		
	Normative	**Poor**	**Very poor**
n (%)	1989 (69%)	779 (27%)	112 (4%)
Birth to 1 year			
Sleep (scale 0 – 4)	3.41 (.018)	3.12 (.034)	2.54 (.116)
Reactivity (scale 0 – 6)	4.55 (.018)	4.40 (.028)	4.19 (.077)
2 to 3 years			
Sleep (scale 0 – 4)	3.53 (.018)	2.84 (.039)	1.79 (.117)
Reactivity (scale 0 – 6)	4.12 (.021)	3.88 (.034)	3.79 (.097)
Persistence (scale 0 – 6)	4.37 (.017)	4.28 (.027)	4.27 (.074)
4 to 5 years			
Sleep (scale 0 – 4)	4 (.000)	2.71 (.016)	0.74 (.042)
Reactivity (scale 0 – 6)	4.54 (.018)	4.2 (.031)	4.07 (.091)
Persistence (scale 0 – 6)	3.97 (.019)	3.72 (.032)	3.74 (.085)

Profile 2 had a likely membership of 27% (*n* = 779) of the sample. It was labelled as the *poor* profile for self-regulation. This group was characterised by decreasing sleep regulation scores across the three waves and just below mean reactivity scores and persistence scores. This profile was consistently distinguishable from the normative profile. However, it was poorly distinguished from the third profile by the reactivity and persistence variables at Waves 2 and 3.

Profile 3 was the smallest group with 4% (*n* = 112) of the sample having a likely probability of being in this profile. This profile was labelled the *very poor* profile for self-regulation. This group showed a steep decline in sleep regulation scores across the waves. It failed to be distinguished from the moderately poor profile on reactivity and persistence at Waves 2 and 3 and was also not clearly distinguished from the normative profile on persistence at Wave 2.

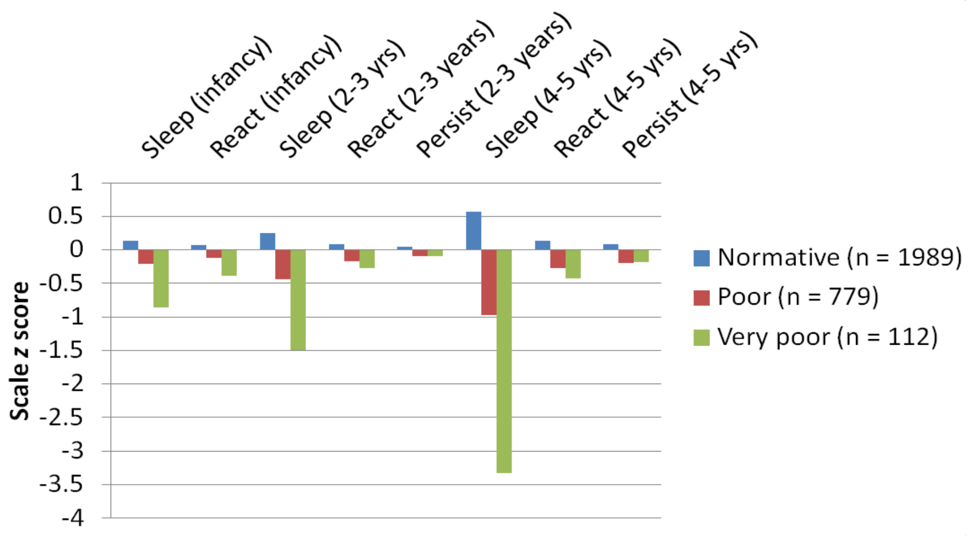

Figure 7.1. Graphical representation of the three longitudinal profiles of self-regulation.

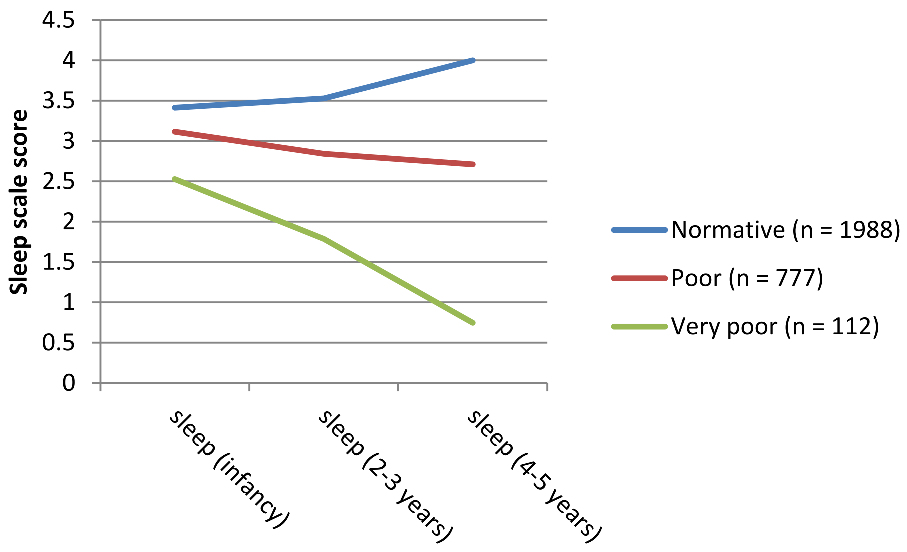

Figure 7.2. Trajectories of sleep regulation in each of the latent profiles of self-regulation.

As the sleep items were measured with the same indicators across the waves it is possible to represent these in a line graph for each profile. Figure 7.2 shows the marked differentiation of the profiles in their sleep regulation over time, with the normative group achieving 'perfect' sleep regulation by Wave 3 (i.e., a score of four out of a possible 0 – 4 scale). The other profiles show a decline in sleep regulation skills, with the very poor self-regulation profile showing the steepest decline in sleep regulatory behaviours.

Profile differences in relation to control and socio-demographic variables

The profiles were examined for differences on each of the control variables. In addition, they were also examined for differences on child age and cultural background. Where the control variable was categorical in nature, paired chi-square tests for independence were used and where the control variable was continuous, ANOVAs with Tukey's post-hoc comparison were used to examine mean differences between the profiles. Results are displayed in Table 7.5.

There were no significant differences in the gender composition of the profiles. There were also no significant differences between the profiles in relation to children speaking a language other than English in the home. Indigenous or Torres Strait Islander children were more likely to be members of the poor regulation profile (x^2 = 7.608, *df* = 2, *p* = .022). Children likely to be in the poor or very poor regulation profiles were significantly younger at Wave 1 than those in the normative profile (*F* = 5.947, *p* = .003). However, the differences were small at .3 of a month for the poor profile and .6 of a month for the very poor profile. At Wave 2, there were no differences in child age across the profiles. At Wave 3 only the very poor profile was significantly younger, though slightly (.9 of a month) than the normative profile (*F* = 5.992, *p* = .003). The children who had poor or very poor self-regulation profiles also had significantly higher scores on the SED index (*F* = 5.992, *p* = .003), and were also more likely to have mothers who reported a significant history of depression at Wave 1 data collection (x^2 = 20.932, *df* = 2, *p* = .000).

Table 7.5 *Profile differences in relation to socio-demographic variables*

Profile	Normative	Poor	Very poor	x^2
n (%)	1989 (69%)	779 (27%)	112 (4%)	
Female	952 (47.86%)	379 (48.65%)	61 (54.46%)	n.s.
Non-English speaking in the home	135 (6.79%)	61 (7.83%)	11 (9.82%)	n.s.
Aboriginal or Torres Strait Islander	37 (1.9%)	28 (3.6%)*	2 (1.79%)	x^2 = 7.608 df = 2 p = .022
Significant history of maternal depression	209 (10.5%)	124 (15.9%)*	22 (19.64%)*	x^2 = 20.932 df = 2 p = .000
M (S.E.)				*F*
Wave 1 child age (months)	8.84 (.057)	8.54* (.091)	8.25* (.24)	5.947 (p = .003)
Wave 2 child age (months)	33.8 (.063)	33.69 (.1)	33.27 (.264)	n.s.
Wave 3 child age (months)	57.51 (.061)	57.30 (.097)	56.69* (.257)	5.992 (p = .003)
Socio-economic disadvantage (SED)	-.262 (.021)	-.057* (.034)	.077* (.090)	F = 5.992 (p = .003)

*Significantly different from the normative profile, however the poor and very poor profiles are not significantly different from each other. n.s. = non-significant.

7.3.3 Predicting behavioural problems and maternal mental health from self-regulation profiles

Two separate path analyses were conducted in Mplus in order to investigate the associations between self-regulation profile membership and the outcomes of interest, while accounting for the control variables of SED, maternal history of depression and child gender. In this section, the descriptive differences between the self-regulation profiles in relation to each outcome variable of behaviour problems and maternal mental health are provided. Following this, the results of the path analyses which further detailed these relationships when the control variables were accounted for, are then set out.

Descriptive differences between self-regulation profiles on outcome measures

The profiles were examined for differences on each of the outcome variables. The SDQ Total Problems Score and the measure for maternal mental health (MMH) were continuous and so ANOVAs with Tukey's post-hoc comparison were used to examine mean differences between the profiles. Membership of either the clinical or broadband ranges of the SDQ was categorical in nature and so paired chi-squared tests were used. Results are displayed in Table 7.6.

Being a member of the poor or very poor self-regulation profiles was associated with higher maternal psychological distress symptoms at Wave 4 (F = 23.97, df = 2, p = .000), and higher scores on the mother-reported SDQ Total Problems Score (F = 43.037, df = 2, p = .000) when compared to the normative self-regulation profile. There were no significant differences among the profiles in relation to teacher-reported behaviour problems. Members of the poorer profiles were also more likely than the normative profile members to be in both the broadband (x^2 = 30.585, df = 2, p = .000) and clinical (x^2 = 23.599, df = 2, p = .000) cut off ranges of the SDQ as reported by mothers. While both poorer profiles differed significantly from the normative profile on these measures, they did not differ significantly from each other. However, a trend, although not statistically significant, in the expected direction can be seen in Table 7.6.

Table 7.6 *Profile differences in relation to behaviour problems and maternal mental health*

Profile	Normative	Poor	Very poor	
n (%)	1989 (69%)	779 (27%)	112 (4%)	
		M (S.E.)		*F*
SDQ Total Problems Score (mother report; SDQm)	7.23 (.104)	8.93* (.188)	9.64* (.532)	*F* = 43.037 *df* = 2 *p* = .000
SDQ Total Problems Score (teacher report; SDQt)	5.0855 (.111)	5.529 (.196)	5.446 (.486)	*F* = 2.219 *df* = 2 *p* = .109
Maternal mental health Wave 4 (MMH)	.449 (.0112)	.586* (.022)	.658* (.010)	*F* = 23.97 *df* = 2 *p* = .000
		n (%)		x^2
SDQ Broadband range (mother report)	195 (9.8%)	129* (16.56%)	22* (19.64%)	x^2 = 30.585 *df* = 2 *p* = .000
SDQ Clinical range (mother report)	86 (4.32%)	64* (8.25%)	13* (11.62%)	x^2 = 23.599 *df* = 2 *p* = .000

*significantly different from the normative profile (p < .05), however the poor and very poor profiles are not significantly different from each other.

Path analysis predicting outcomes from profile membership

This path analysis involved the regression of the same outcomes of interest used in previous studies, on the self-regulation problems variable. This variable was created from the profile membership assigned to each participant. Those in the normative profile were scored one, the poor profile were scored two and the very poor profile were scored three. Therefore higher scores represented the presence of more early childhood self-regulation problems. The outcomes were the SDQ Total Problems Scores as reported by mothers (SDQm), and maternal mental health at Wave 4 (MMH). Teacher-reported behaviour problems were not included as the descriptive analyses above showed no differences among the profiles on this measure. The effects of SED, child gender and maternal history of depression on self-regulation problems and both outcome measures were controlled for. Where paths related to control variables were found to be non-significant, these were then trimmed in line with recent recommendations (Little, 2012). The regression of self-regulation problems on to child gender was non-significant. This is not surprising given that in bivariate analyses, there were no significant gender differences between the self-regulation profiles. There was also no significant effect for gender in relation to maternal mental health. These paths were therefore trimmed.

The trimmed model was an ‘excellent’ fit for the data by the chi-square test for absolute fit and thus other fit indices are not reported (x^2 = .826, df = 2, p = .662). All paths were significant and relationships were in the expected direction. Unstandardised and standardised estimates are found in Table 7.7 and standardised estimates are provided in the path diagram shown in Figure 7.3. Results show that even when the effects of the covariates were accounted for, there was still a small but significant effect for self-regulation problems in relation to mother-reported behaviour problems (β = .155) and maternal mental health (β = .115) measured at 6-7 years old. This model accounted for only 8.3% of the variance in behavioural problems and 10% of the variance in maternal mental health as indicated by the r-square values shown in Figure 7.3. It is clear that there are many other factors associated with these outcomes for children and mothers which were not included in this model.

Table 7.7 *Path analysis results for the effect of self-regulation profile membership (self-regulation problems) on later behavioural problems and maternal mental health*

Parameter Estimate	Unstandardised *(se)*	Standardised	*p*
SR problems → SDQm	.749	.155	.000
SR problems → maternal mental health	.061	.115	.000
Gender (boy) → SDQm	1.039	.220	.000
History of depression → SDQm	1.752	.371	.000
SED → SDQm	.751	.147	.000
History of depression → maternal mental health	.451	.879	.000
SED → maternal mental health	.024	.043	.018
History of depression → SR problems	.261	.261	.000
SED → SR problems	.136	.128	.000
Covariance SDQm and Maternal mental health	.691	.289	.000

SR problems = self-regulation problems, a variable derived from latent profile membership.

The effects of the control variables show that a significant history of maternal depression had the strongest effect on both the maternal mental health outcome (β = .879) and behavioural problems (β = .371). A history of maternal depression was also a moderate predictor of early childhood self-regulation problems (β = .261). Boys were more likely to have higher degrees of mother-reported behaviour problems (β = .220) as were children from more disadvantaged households (β =.147). Level of disadvantage also predicted early childhood self-regulation problems (β = .128).

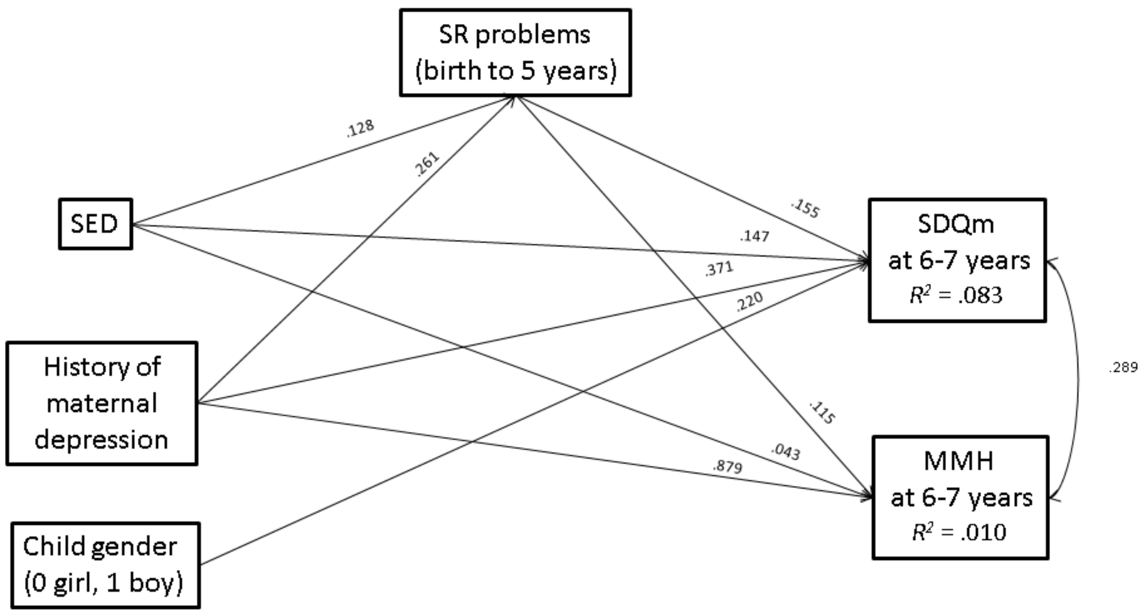

Figure 7.3. Path model for the relationship of early childhood self-regulation problems to later behaviour problems and maternal mental health. All paths are significant and standardised estimates are shown. Fit statistics: x^2 = .826, *df* = 2, *p* = .661. SR problems = self-regulation problems, a variable derived from latent profile membership; SED = socio-economic disadvantage; SDQm = mother-reported social, emotional and behavioural problems; MMH = maternal mental health.

A number of mediated pathways were apparent in this model and so these were tested for significance using the bootstrap procedure. Self-regulation problems mediated the effects of SED on both behavioural problems ($\beta_{\text{SED}\rightarrow\text{SR probs}\rightarrow\text{SDQm}}$ = .020, p = .000) and maternal mental health ($\beta_{\text{SED}\rightarrow\text{SR probs}\rightarrow\text{MMH}}$ = .015, p = .000). Self-regulation problems also mediated the effect of maternal history of depression on later behaviour problems ($\beta_{\text{depression}\rightarrow\text{SR probs}\rightarrow\text{SDQm}}$ = .131, p = .000) and maternal mental health ($\beta_{\text{depression}\rightarrow\text{SR probs}\rightarrow\text{MMH}}$ = -285, p = .000).

7.3.4 Maternal parenting and mental health as mediators of the relationship between self-regulation profiles and later behavioural problems

The next path analysis investigated the extent to which maternal parenting and mental health mediated the relationship between self-regulation problems from birth to 5 years (the variable derived from profile membership), and behavioural problems as reported by mothers when children were 6-7 years old. Descriptive differences between the self-regulation profiles on maternal parenting behaviours are first provided. The results of the path analysis follow.

Descriptive differences between the self-regulation profiles on maternal parenting and mental health

The profiles were examined for differences on each of the maternal parenting variables. These were measured by mother self-report at Wave 3 when children were 4-5 years old and are the same set of variables used in the previous study. As each of these is a continuous score, ANOVAs with Tukey's post-hoc comparison were used to examine mean differences between the profiles. Results are displayed in Table 7.8.

Being a member of the poor or very poor self-regulation profiles was associated with higher maternal parenting hostility (F = 22.72, df = 2, p = .000), higher levels of parenting anger (F = 29.38, df = 2, p = .000), lower consistency (F = 63, df = 2, p = .000), lower maternal self-efficacy (F = 41, df = 2, p = .000) and more symptoms of psychological distress in mothers (F = 28.83, df = 2, p = .000) when compared to the normative self-regulation profile. There were no significant differences among the profiles in relation to maternal parenting warmth or inductive reasoning. While both poorer profiles differed significantly from the normative profile on these measures, they did not differ significantly from each other. However, a trend, although not statistically significant, in the expected direction can be seen in Table 7.8.

Table 7.8 *Profile differences in relation to maternal parenting and mental health*

Profile	Normative	Poor	Very poor	
n (%)	1989 (69%)	779 (27%)	112 (4%)	
		M (S.E.)		*F*
Warmth	4.538 (.010)	4.517 (.017)	4.476 (.047)	1.386 (*p* = .250)
Hostility	3.084 (.028)	3.412* (.305)	3.554* (.142)	22.720 (*p* = .000)
Anger	1.753 (.012)	1.902* (.021)	2.036* (.072)	29.375 (*p* = .000)
Inductive reasoning	4.213 (.013)	4.165 (.022)	4.1638 (.062)	1.958 (*p* = .141)
Consistency	5.223 (.013)	4.943* (.025)	4.914* (.066)	63.006 (*p* = .000)
Self-efficacy	4.439 (.301)	4.220* (.024)	4.147* (.066)	40.998 (*p* = .000)
Maternal mental health	.4633 (.011)	.608* (.021)	.705* (.0592)	28.832 (*p* =.000)

*significantly different from the normative profile, however the poor and very poor profiles are not significantly different from each other.

Path analysis with aspects of maternal parenting as mediators

This path analysis involved the regression of the outcomes of mother-reported behavioural problems on each of the maternal parenting variables, and the self-regulation problems variable derived from latent profile membership. The effects of SED, child gender and maternal history of depression on self-regulation problems, the outcome measure and each of the parenting variables were controlled for in the initial estimation. Where paths related to control variables were found to be non-significant, these were then trimmed in line with recent recommendations (Little, 2012). There were no associations between child gender and self-regulation problems, consistency, reasoning, warmth, hostility or maternal mental health. There were also no associations between a history of maternal depression and consistency or warmth. Finally, there were no effects for SED in relation to reasoning or maternal mental health. These paths were therefore trimmed. The remaining results in relation to the control variables are not presented here as they were highly similar to the findings presented in the previous chapter.

The trimmed model was an ‘excellent’ fit for the data by the chi-square test for absolute fit and thus other fit indices are not reported (x^2 = 11.582, *df* = 10, *p* = .314). Unstandardised and standardised estimates are found in Table 7.9 and standardised estimates for the significant paths only are provided in the path diagram shown in Figure 7.4. All paths were significant with the exception of the following. Mother-reported behaviour problems were not predicted by consistency, reasoning or warmth and self-regulation problems showed no significant association with maternal warmth.

The direct effect for self-regulation problems in relation to mother-reported behaviour problems was again found (β = .079). This confirms the findings found in the model presented in Section 7.5.2, but represents a decreased direct effect size as would be expected in mediation models. Direct effects were also found in relation to maternal parenting. Maternal parenting hostility, anger, self-efficacy and mental health as measured at Wave 3 significantly predicted mother-reported behaviour problems two years later. These relationships were all in the expected direction. More mother-reported behaviour problems were predicted by higher maternal parenting hostility (β = .069), higher maternal parenting anger (β = .202), lower levels of maternal self-efficacy (β = -.119) and higher symptoms of psychological distress in mothers (β = .100) two years earlier.

All maternal parenting and mental health variables measured at Wave 3 were predicted by children's self-regulation problems over the first five years, with the exception of maternal parenting warmth. More early childhood self-regulation problems as measured by membership of the poorer profiles was associated with higher parenting hostility (β = .138), higher parenting anger (β = .156), less inductive reasoning (β = -.050), lower levels of consistency (β = -.217), poorer maternal self-efficacy (β = -.182) and more symptoms of psychological distress in mothers (β = .138).

Evidence for the hypothesised mediated pathways was found only in relation to maternal self-efficacy, mental health, parenting anger and hostility. These aspects of parenting met the requirements for mediation in that they were each significantly associated with the predictor and the outcome variables, and their inclusion in the model reduced the strength of the direct association between the predictor and the outcome variables. To test the significance of these indirect pathways, the model was run again using the bootstrap procedure as recommended by MacKinnon (2012) and significance of these paths was confirmed. The estimates for the significant mediated pathways (total effects) are found in the final section of Table 7.9.

The results provide evidence for several maternal parenting behaviours and mental health acting as mediators in the relationship between early childhood self-regulation problems and behavioural problems at 6-7 years of age. This relationship was partially mediated by maternal efficacy ($\beta_{\text{SR probs}\rightarrow\text{efficacy}\rightarrow\text{SDQm}}$ = .022, p = .000), hostility ($\beta_{\text{SR probs}\rightarrow\text{hostility}\rightarrow\text{SDQm}}$ = .010, p = .000), anger ($\beta_{\text{SR probs}\rightarrow\text{anger}\rightarrow\text{SDQm}}$ = .032, p = .000) and mental health ($\beta_{\text{SR probs}\rightarrow\text{MMH}\rightarrow\text{SDQm}}$ = .014, p = .000). This model accounted for 21.5% of variance in mother-reported behavioural problems. This was a substantial increase from the 8.7% of variance in behaviour problems accounted for by the previous path model which did not including parenting variables.

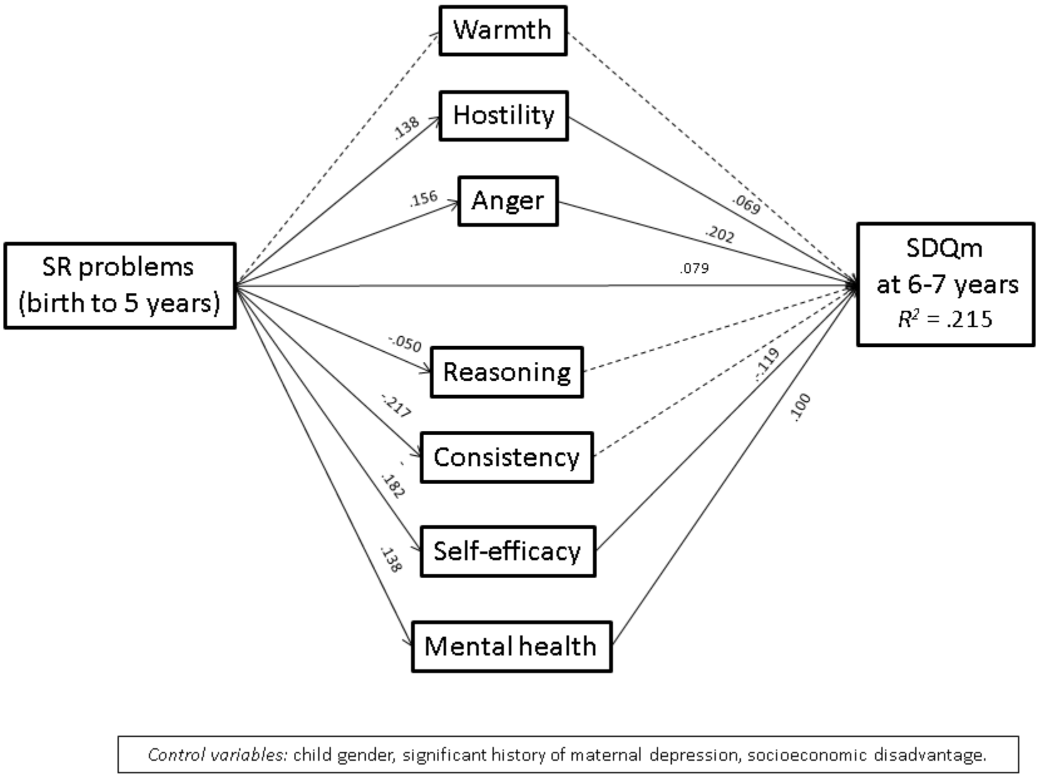

Figure 7.4. Path model for the relationship of self-regulation problems to behaviour problems mediated by maternal parenting and mental health. Dashed lines are non-significant paths. Standardised estimates are shown. Fit statistics: x^2 = 11.582, df = 10, p = .314.

Table 7.9 *Path analysis results for the role of maternal parenting and mental health as mediators of self-regulation profile membership (self-regulation problems) in relation to behaviour problems*

Parameter	**Unstandardised *(se)***	**Standardised**	***p***
Relationships of self-regulation problems and parenting to mothe- reported behaviour problems			
SR problems → SDQm	.323 (.106)	.079	.000
Warmth → SDQm	-.197 (.216)	-.019	.363
Hostility → SDQm	.262 (.067)	.069	.000
Anger → SDQm	1.739 (.161)	.202	.000
Reasoning → SDQm	.193 (.161)	.024	.230
Consistency → SDQm	.001 (.129)	.000	.997
Self-efficacy → SDQm	-.915 (.122)	-.119	.000
Maternal mental health → SDQm	.917 (.136)	.100	.000
Relationships of self-regulation problems to parenting			
SR problems → Warmth	-.020 (.011)	-.044	.064
SR problems → Hostility	.177 (.029)	.138	.000
SR problems → Anger	.087 (.012)	.156	.000
SR problems → Reasoning	-.030 (.014)	-.050	.030
SR problems → Consistency	-.137 (.014)	-.217	.000
SR problems → Self-efficacy	-.144 (.014)	-.182	.000
SR problems → Maternal mental health	.072 (.011)	.138	.000
Effects of control variables			
SED → SDQm	.635 (.091)	.124	.000
SED → SR problems	.144 (.025)	.136	.000
SED → Warmth	.028 (.009)	.058	.002
SED → Hostility	.063 (.025)	.047	.011
SED → Anger	.027 (.010)	.045	.000
SED → Consistency	-.089 (.012)	-.133	.000
SED → Self-efficacy	-.057 (.012)	-.086	.000
Gender (male) → Anger	.056 (.021)	.086	.008
Gender (male) → Self-efficacy	-.066 (.024)	-.104	.005
History of maternal depression → SDQm	.986 (.226)	.081	.000
History of maternal depression → SR problems	.292 (.071)	.292	.000
History of maternal depression → Hostility	.232 (.071)	.179	.001
History of maternal depression → Anger	.112 (.029)	.197	.000
History of maternal depression → Reasoning	.075 (.034)	.124	.000
History of maternal depression → Self-efficacy	-.101 (.033)	-.159	.002
History of maternal depression → Maternal mental health	.414 (.023)	.807	.000
Significant mediated effects			
SR problems → Hostility → SDQm	.046 (.016)	.010	.004
SR problems → Anger → SDQm	.152 (.029)	.032	.000
SR problems → Self-efficacy → SDQm	.104 (.024)	.022	.000
SR problems → Maternal mental health → SDQm	.066 (.018)	.014	.000

7.4 Discussion

This study explored the research question: What are the profiles of self-regulation in children aged birth to 5 and how are they related to child outcomes and parenting? It built on the previous studies by taking a person-centred approach to the construct of self-regulation, complementing the variable-centred approach taken in the confirmatory factor analyses of Study 1. This study used the same self-regulation measures used throughout this thesis in a longitudinal profile analysis which explored the typologies of development over time for children in relation to sleep regulation, reactivity and persistence. This allowed for the emergence of a longitudinal picture of self-regulation development in Australian children aged birth to 5 years, despite the changing measures across this time.

Three longitudinal profiles of self-regulation development from birth to age 5 were found. They were well separated with very high entropy and classification probabilities. The profiles made substantive sense in that a normative profile emerged with likely membership of 69% of the sample. This profile was characterised by improving sleep regulation across the first five years and consistently higher scores on reactivity and persistence. The poor profile and very poor profiles had likely memberships of 27% and 4% of the sample respectively. These profiles were generally very well distinguished from the normative profile and were characterised by consistently poorer scores on reactivity and persistence and decreasing sleep regulation scores over time, with the very poor profile showing the steepest decline.

An investigation of the differences between the profiles on the selected control variables showed that child gender and a non-English speaking home environment were not related to profile membership. This finding is in contrast with studies that find gender differences in relation to self-regulation, with girls tending to have less regulatory problems (Gagne & Goldsmith, 2011; Hill et al., 2006; Sanson et al., 2009; Schmid et al., 2010), however other studies have found no gender differences (Colman et al., 2006; Degnan et al., 2008; Graziano et al., 2010). Study 2 found that being a boy was associated with lower levels of sleep regulation in infancy, poorer emotional regulation (reactivity) in toddlerhood and at 4-5 years and poorer cognitive regulation (persistence) at 4-5 years. It appears then that there may be gender differences in specific aspects of self-regulation at specific times, but no gender effects in relation to broader longitudinal self-regulation typologies over the first five years.

Cultural background or race differences are typically not found in self-regulation studies (Colman et al., 2006; Degnan et al., 2008; Hill et al., 2006) and have not been included as variables in most of the more recent studies. The lack of association between self-regulation profile membership and non-English home environment found in this study is therefore not surprising. Children who were most likely to be in the poor regulation profile were also more likely to be identified as Aboriginal and Torres Strait Islander (ATSI), a group unique to Australia, and not represented in the self-regulation literature to date. However, within this study sample, the overall proportion of ATSI children is low. As cultural differences in self-regulation were not a focus of the current study, ATSI status was not maintained as a control variable in the subsequent studies presented in this chapter or throughout the thesis. Future research should pursue this agenda more carefully.

There were significant differences between the profiles on child age at various data collection points, with the poorer self-regulation profiles generally being significantly younger than the normative profile. However, these differences were quite small and were consistently less than one month; therefore, child age was not maintained as a control variable in subsequent analyses. There were also significant differences between the profiles on socio-economic disadvantage and maternal history of depression. In both instances the poor and very poor profiles were well distinguished from the normative profile on these measures but were not differentiated from each other at a statistically significant level. These findings concur with others who have found that children with poorer self-regulation are more likely to come from lower socio-economic environments (Degnan et al., 2008; Graziano et al., 2010) and are also more likely to have mothers with a history of depression (Hoffman et al., 2006; Hughes & Ensor, 2009).

Membership of the poorer self-regulation profiles predicted more mother-reported behaviour problems and symptoms of psychological distress in mothers two years later. These confirm the findings in Study 2 and add additional evidence for the child-driven effects on maternal mental health. Even with the inclusion of a significant history of maternal depression as a control variable in the model, poor self-regulation typology over the first five years still predicted maternal mental health two years later. In comparing the predictive power of the longitudinal self-regulation profiles with reactivity and persistence in toddlerhood (examined in Study 3), it appears that the profiles are not as powerful. The profiles were unable to predict teacher-reported behaviour problems (although toddler reactivity was able to) and were a weaker predictor of mother-reported behaviour problems than toddler reactivity and persistence. This may reflect the bias inherent in using only mother-reported self-regulation over time as maternal perceptions of children's behaviour may be influenced by earlier child behaviour. Future research should use multi-informant and multiple-context measurement models for self-regulation.

It is particularly interesting to note that Study 2 found no direct relationship between sleep regulation and later outcomes for children or mothers. Meanwhile in this study, problems with sleep regulation (in combination with poorer emotional and cognitive regulation) emerged as the most distinguishing feature between the normative and poorer self-regulation profiles. This seems to reflect the finding from Study 1 that the correlations among sleep regulation and the other regulation measures decreased substantially from toddlerhood on. Examination of the longitudinal self-regulation profiles reflects this with relatively stable emotional and cognitive regulation across waves for each profile but increasing diversity in sleep regulation among the profiles. It is important to interpret these findings bearing in mind the possibility that in the current study, ongoing problems with sleep regulation from 2-3 years could be increasingly a reflection of the parenting environment including maladaptive responses to initial infant sleep problems (Bordeleau et al., 2012). The longitudinal associations between parenting and sleep regulation across early childhood should be examined more carefully in future studies.

The mediating role of children's self-regulation profile in the relationship between early risk (socio-economic disadvantage and history of maternal depression) and later behaviour problems was also confirmed in this study. Although not a focus of the current program of research, the findings confirm other recent research that has found evidence for the buffering effect that self-regulation skills and more 'easy' temperament traits may provide children in the context of environmental risk (Derauf et al., 2011; Dilworth-Bart, 2012). These findings indicate that programs that aim to improve self-regulation skills in children, particularly those from vulnerable backgrounds, may be highly beneficial.

Similarly to the findings in Study 3, the relationship between early childhood self-regulation typology and later behaviour problems was mediated by maternal anger, self-efficacy and mental health. In addition, the model in this chapter identified maternal parenting hostility as a mediator. A substantial limitation of the mediational model is the fact that prior levels of the maternal variables were not controlled for, weakening the interpretation that children's self-regulation typology had a causal effect on parenting which then had a causal effect on behaviour problems. However, the child-driven effects on maternal mental health found in Study 2, along with other recent research confirming the hypothesis that child behaviour influences parental behaviour lend support to these findings (Healy et al., 2011; Van der Bruggen et al., 2010; Verhoeven et al., 2010). Future work should confirm these findings

One interpretation of the parenting-as-mediator finding is related to the mutual exacerbation theory first discussed in Chapter 5 in relation to child self-regulation and maternal mental health. In the study presented in the current chapter, the normative and poorer profiles differentiated children from infancy, with those in the poorer profiles having more sleep problems as reported by mothers. If these sleep problems continue or even worsen in children (as they did for the poor and very poor profiles) it is likely that mothers will be more likely to intervene at night which predisposes mothers to significant sleep loss and poorer mental health (Bayer et al., 2007; Meltzer & Mindell, 2007). These may in turn lead to more negative maternal parenting including higher levels of anger and hostility as found in this study. Future studies should seek to confirm this hypothesis with more robust designs such as cross-lagged longitudinal panel models that allow for bidirectional effects and controlling for prior levels of each variable.

7.5 Conclusion

The study presented in this chapter took a person-centred approach to analysis by establishing three longitudinal latent profiles of self-regulation over the first five years. Sleep, reactivity and persistence were used as indicators and three profiles emerged. Most children in the sample were in the normative profile. A total of 31% were found to be in the poor or very-poor self-regulation profiles, distinguished particularly by their declining sleep regulation from birth to 5 years. Children in the poorer profiles were more likely to have a mother with a significant history of depression, be from a more socio-economically disadvantaged home, and have more mother-reported behaviour problems and poorer maternal health at 6-7 years of age. Maternal parenting hostility, anger, self-efficacy and mental health mediated the relationships between early childhood self-regulation typology and later outcomes for children.

This study contributes to a broad understanding of the self-regulation development of Australian children in relation to mother-reported sleep, emotional and cognitive regulation. Importantly, it signals for the first time, the prevalence of sustained self-regulation problems (as perceived by mothers) in the early years as occurring in approximately 31% of Australian children. These problems put mothers at risk of poorer mental health, less positive parenting behaviours and increased social, emotional and behavioural problems in later childhood. Mothers with a history of depression who report their child as having poor sleep regulation and poorer emotional regulation early in life may be a particular risk group. Early intervention and prevention efforts should aim to identify and support these families. The findings of this study suggest that supporting parents in approaches to encouraging early sleep regulation in young children could be an important area to address.

This and the preceding chapters of results have presented the findings of a program of research that included four individual studies. Study 1 explored the use of mother-reported sleep regulation and temperamental reactivity and persistence in the development of measurement models for early childhood self-regulation. It also documented the longitudinal relationships among these variables. Study 2 confirmed the predictive validity of these indicators in relation to later social, emotional and behavioural problems for children. It also addressed the bidirectionality of relationships between children's self-regulation and maternal mental health across time, finding evidence for both mother- and child-driven effects. Study 3 explored the role of maternal parenting and mental health in the context of children's self-regulation and later outcomes and found maternal self-efficacy, mental health and parenting anger to mediate the relationship between emotional and cognitive regulation in toddlerhood and behaviour problems later in childhood. Study 4 took a person-centred approach and established three longitudinal self-regulation profiles which were predictive of similar outcomes and related in similar ways to maternal parenting. The next chapter is the final chapter in this thesis and will synthesise the results and position them within the current body of research examining self-regulation development. It will also address the limitations of the current study and discuss the implications for theory, policy, practice and future research in this area.

CHAPTER 8: DISCUSSION AND CONCLUSION

8.1 Introduction

This thesis has explored early childhood self-regulation skills, associated behavioural outcomes for children, and transactional relationships with the maternal parenting environment in a group of Australian children participating in *Growing Up In Australia: The Longitudinal Study of Australian Children (LSAC)*. The research set out in this thesis has addressed a number of the issues and questions arising from the existing body of research. Importantly, this study represents the first longitudinal examination of multiple domains of self-regulation in Australian children using panel survey data.

The program of research embraced a broad concept of self-regulation from infancy to age 5 that included biobehavioural, emotional and cognitive aspects of regulation examined longitudinally. In an important innovation, mother-reported sleep regulation was included as an indicator of self-regulation not only in infancy as done in previous studies (Choe, 2012; Schmid et al., 2010), but across early childhood. Finally, the analyses set out in this thesis examined the reciprocal relationships between maternal mental health and children's self-regulation across the first seven years of life. This study is the first, to the author's knowledge, to establish empirical evidence for child-driven effects in relation to self-regulation and maternal mental health during early childhood.

The analysis plan for this thesis addressed a number of methodological limitations of prior studies. First, the study used a large sample of Australian children and thus contributes substantial new knowledge relevant to the Australian context within a large body of self-regulation research conducted primarily in North America and Europe. Second, only short mother-report measures were used as indicators of self-regulation. This allows the findings to be directly transferrable to practice environments providing an advantage over most laboratory-based measures of self-regulation which are not feasible to undertake in early childhood practice settings. Third, both mother-reported and teacher-reported social, emotional and behaviour problems were used as outcome measures. This provided data on child behaviours across two different settings by two different informants helping to guard against issues of shared method variance. Finally, contemporary statistical techniques within a structural equation modelling framework allowed for the careful examination of the measurement properties of the self-regulation variables selected, continued modelling of measurement error throughout the structural models, and controlling for prior levels of particular variables and important socio-demographic variables. This is a more rigorous and robust analytic methodology than other multivariate techniques often used including linear regression.

This chapter provides an in-depth discussion of the findings, their contribution to the field, the implications for policy, practice and research, and the limitations of the work. The first section will provide the reader with a succinct summary of the findings in relation to each of the four research questions presented in this thesis. This will serve to orient the reader to the four studies in turn. Following this, the findings as a whole will be discussed in relation to the themes that emerged across the studies. This will provide the reader with an understanding of the value and significance of the findings as a whole and supports greater integration of the collective findings into new knowledge.

8.2 Summary of Findings

Four studies were conducted for this thesis. The aim of this section is to provide the reader with a brief re-orientation to each research question and the main findings related to each. The following sections in this chapter will then discuss the findings in more detail.

Study 1 addressed the question: What are the relationships among parent-reported sleeping problems, temperamental reactivity and temperamental persistence over the first five years and what do they tell us about early childhood self-regulation? In this study, confirmatory factor analysis was used to establish measurement models for latent variables of sleep regulation, reactivity (selected to represent emotional regulation) and persistence (selected to represent cognitive regulation) at each of infancy, ages 2-3 years and 4-5 years. From this point on in the discussion, the terms emotional regulation and cognitive regulation will be used rather than reactivity and persistence. This is in order to better represent the research in the context of the literature review presented in Chapter 2. Overall, these measurement models fit the data well. The indicators used changed over time due to the study design which accommodated the rapidly changing development of children across this period of life. This meant that longitudinal measurement invariance could not be established.

A cross-lagged longitudinal model yielded results on homotypic and heterotypic continuity of the self-regulation components. Heterotypic continuity was strongest in infancy and became weaker over time suggesting an increasing differentiation of self-regulation processes across the early childhood period. Homotypic continuity strengthened over time providing evidence for the increasing stability of self-regulation capacities in each of the domains across the first five years. Some evidence for the predictive validity of the self-regulation measures explored in this study was found in Study 2 when the measures predicted later mother-reported and teacher-reported behaviour problems; and, in Study 4, when the measures identified those children with persistent regulation problems across the early years.

Study 2 addressed the question: How is self-regulation from birth to age 5 associated with maternal mental health across time, and children’s social, emotional and behavioural outcomes at age 6-7? At 2-3 years, emotional and cognitive regulation predicted mother-reported problems at 6-7 years and emotional regulation also predicted teacher-reported problems. At 4-5 years emotional and cognitive regulation predicted both teacher-reported and mother-reported behaviour problems two years later. These relationships were found while controlling for prior levels of self-regulation in children indicating that *changes* in emotional and cognitive regulation across the early childhood period are important in understanding their relationship to later outcomes for children. Contrary to expectation, sleep regulation at any age did not have any direct relationship with later problems, but did exert an indirect effect through its influence on children’s emotional and cognitive regulation across early childhood.

As hypothesised, empirical evidence was found for the bidirectional relationships between maternal mental health and children’s self-regulation across the early childhood period. Specifically, a significant history of maternal depression prior to the birth of the child was associated with poorer sleep and emotional regulation during infancy and at 2-3 years. Maternal mental health symptoms during toddlerhood contributed to poorer emotional regulation two years later and mother's mental health symptoms at 4-5 years contributed to mother-reported behaviour problems two years later. Child-driven effects were found for emotional regulation at 2-3 years and 4-5 years with better emotional regulation in children contributing to more positive maternal mental health two years later. In sum these findings suggest that early in life mother-driven effects are stronger and from toddlerhood child-driven effects become apparent. These findings contribute important empirical evidence for the transactional developmental pathways involving self-regulation and maternal mental health.

Study 3 addressed the research question: Is the relationship between children's self-regulation during the third year and child behavioural outcomes in the seventh year moderated or mediated by maternal parenting and mental health measured in the fifth year? Yes, the relationship between reactivity and persistence at 2-3 years and behaviour problems at 6-7 years is variously mediated by maternal self-efficacy, parenting anger and mental health in the intervening years. This study used structural equation modelling to investigate the extent to which seven aspects of maternal parenting moderated or mediated the relationship between toddler emotional and cognitive regulation and behaviour problems four years later. No moderating effects were found but several mediation effects were. Specifically, maternal self-efficacy mediated the relationship between toddler emotional and cognitive regulation and mother-reported behaviour problems. Additionally, self-efficacy mediated the relationship between toddler emotional regulation and teacher-reported behaviour problems. Maternal parenting anger and mental health also mediated the relationships between toddler emotional and cognitive regulation and mother-reported behaviour problems. Taken together, these results support the group of existing studies that provide evidence for the critical role maternal parenting plays in child development, and specifically in the development of self-regulation. This study was considered exploratory in nature and is limited by a number of methodological issues.

Study 4 addressed the research question: What are the longitudinal profiles of self-regulation in children aged birth to 5 and how are they related to child outcomes and parenting? This study turned to a person-centred analytic approach and used latent profile analysis to establish three profiles of self-regulation development in young Australian children. The “poor” and “very poor” self-regulation profiles represented 27% and 4% of children respectively. These poorer profiles were distinguished from the normative profile by consistently poorer emotional and cognitive regulation scores across time and decreasing sleep regulation scores. As hypothesised, profile membership was predictive of later behaviour problems and maternal mental health in the expected direction. In addition a number of maternal parenting behaviours including hostility, anger and self-efficacy and maternal mental health mediated the relationship between profile membership and later outcomes. These findings serve to further validate the use of brief mother-report measures as feasible indicators of early childhood self-regulation. Importantly, this is the first study to provide a prevalence estimate of consistent multi-domain early childhood self-regulatory problems in Australian children, as reported by mothers. These children are more likely to be part of an environment that includes ongoing problems with maternal mental health and are at greater risk of behavioural problems after entering school.

Across the studies, the effects of gender and socio-economic status were controlled for. Overall, children from lower socio-economic backgrounds had poorer self-regulatory skills across early childhood. Boys tended to have poorer self-regulatory skills at specific points in time, but there were no gender differences in the longitudinal profiles of self-regulation development from birth to 5 years. A more detailed discussion of gender and socio-economic effects is provided in Section 5.4.3 but not repeated here in the interest of a focus on the specific research questions guiding the thesis. The following sections will discuss the findings of this program of research in relation to a number of key themes.

8.3 Contributions of this Research Program

The research presented in this thesis contributes important new knowledge regarding self-regulation development in children. It did so by using a large, longitudinal Australian dataset and contemporary statistical modelling techniques. A novel approach to the measurement of self-regulation using both sleep problems and temperament as indices was presented. For the first time the longitudinal and reciprocal relationships among sleep, emotional and cognitive regulation across the critical birth to 5 year period were documented. A prevalence rate for sustained early childhood self-regulation problems in Australian children was established and it was confirmed that these problems present a risk for children in relation to behavioural problems following school entry. Importantly, unique and new evidence for both mother- and child-driven effects in relation to self-regulation and maternal mental health were documented.

In this section, themes that emerged across the thesis will be addressed in turn. The pertinent findings and contributions of this study in relation to each will be discussed and the implications for theory and future research will also be presented. The themes are: the measurement of self-regulation, self-regulation across the early childhood period, prevalence rates of early childhood self-regulation problems in Australian children; early childhood self-regulation and later behavioural problems; bidirectional relationships between early childhood self-regulation and maternal mental health; and, the role of maternal parenting in the path between early self-regulation and later behavioural outcomes.

8.3.1 Measurement of self-regulation

The body of research to date has measured self-regulation in childhood in a myriad of ways. Parent-report, teacher-report, physiological measures, trained observer ratings and laboratory tests have all been variously used. While each of these methodologies has added unique information to our understanding of self-regulation and its development, no one form of measurement stands out as superior in terms of reliably measuring the construct as a whole in early childhood. One of the aims of this program of research was to explore the extent to which broad self-regulation can be measured in early childhood by using brief parent-report measures available in a large Australian dataset.

This thesis contributes to new understandings of self-regulation measurement by taking a unique approach whereby sleep problems and items from temperament measures tapping emotional and cognitive regulation were selected to explore self-regulation from infancy to age 5. Decisions about which items to use were made in reference to previous studies that have used similar parent-report temperament items to measure self-regulation (Fan, 2012; Bridgett et al., 2011; Sanson et al., 2009) and also on examination of the face validity of the items included. The selection of mother-reported sleep problems as a measure of biobehavioural regulation was supported by other research that has used mother-reported infant sleep problems to identify dysregulated infants (Choe, 2012; Schmid et al., 2010; Zentall et al., 2012).

In measuring self-regulation in this way, this study makes an important contribution to bridging the gap between studies of infant sleeping, crying, and eating patterns and temperament studies that address self-regulation in early childhood. The measurement models for sleep, emotional and cognitive regulation at each of infancy, 2-3 years and 4-5 years of age were found to fit the data well. In addition, the latent variables were found to have predictive validity in regards to later social, emotional and behavioural outcomes for children. These indicators also reliably identified those children with a profile of poor self-regulation across early childhood from those with normative development in this area in the latent profile analysis. Profile membership was also a significant predictor of later behavioural outcomes for children. Taken together, these findings suggest that the items included can be used to measure a holistic construct of self-regulation across this period of childhood.

The inclusion of sleep as a measure of self-regulation beyond the infancy period presents a particularly unique aspect to the research presented in this thesis. While previous studies have examined the correlations among sleep regulation and temperament during infancy (Hayes et al., 2011), and the predictive power of early sleep problems in relation to later self-regulation (Bernier et al., 2013), this study has been the first to use parent-reported sleep, emotional and cognitive regulation in an effort to measure the broad, multidimensional construct of self-regulation across both infancy and early childhood.

The extent to which the sleep regulation latent variable actually represents children’s ability to self-regulate their own sleep or reflects the effect of parental approaches to managing children’s sleep over time is worthy of more careful consideration. It may be that in the current study, ongoing problems with sleep regulation, particularly from after the infancy period, were increasingly a reflection of the parenting environment including maladaptive responses to initial infant sleep problems, as documented in other studies (Bernier et al., 2012; Bordeleau et al., 2012). Alternatively, ongoing early childhood sleep problems might reflect an underlying trait in children for poor self-regulation, or a deviance from the normative pathway of increasing development of self-regulatory abilities from infancy. Van den Bergh and Mulder (2012) found that foetuses in the third trimester who exhibited more smooth transitions between active and passive sleep had higher levels of mother-reported effortful control at 8-9 years and 14-15 years of age. These authors posit that near-term foetal sleep regulation is indicative of central nervous system maturity and also of the degree of neural plasticity present in the individual which allows for the subsequent development of higher self-regulatory capacity.

Evidence from the current study that speaks to this issue on the extent to which ongoing sleep regulation is a result of child or parental influence, or both, is mixed. On one hand, sleep and emotional regulation were highly correlated during infancy reflecting other research findings which indicate infant sleep regulation to be correlated with more positive temperament typologies (Spruyt et al., 2008). The extent to which sleep regulation improved across the first five years, or declined, also clearly separated the poor self-regulation profiles from the normative profile in the final study. These profiles were predictive of later behavioural outcomes for children. This evidence suggests that sleep regulation may be an early behavioural manifestation of an individual's unique capacity for self-regulation.

On the other hand, sleep regulation was only minimally correlated with emotional and cognitive regulation from 2-3 years on, when other studies have found an ongoing association between temperamental aspects of self-regulation and sleep regulation from early childhood (El Sheikh & Buckhalt, 2005) through to adolescence (Moore et al., 2011). This seems to suggest that sleep, emotional and cognitive regulation became more independent across time in the current study. This divergence raises questions about the extent to which mother-reported sleep problems became more an artefact of parental approaches to sleep rather than individual child differences in regulatory capacity. The analyses in the current study did not address this issue, but future studies could by examining the extent to which children’s sleep problems are correlated with parental behaviours. Transactional models that test the associations between parenting and children’s sleep problems could also be tested. Using multiple methods of data collection rather than relying solely on mother report would also better address some of these issues. The use of more objective measures of child sleep regulation will be important as maternal report of sleep issues may be influenced by other maternal or child factors.

8.3.2 Self-regulation across the early childhood period

The longitudinal modelling of the relationships among multiple domains of self-regulation (sleep, emotion and cognition) right across the early childhood period represents a significant contribution to this field of study. Homotypic stability in these self-regulation indicators was moderate but increased over the course of the first five years (Putnam et al., 2006; Sanson et al., 2009). Higher degrees of stability would be expected from 6 years of age and should be tested in future research. These findings reflect those of many longitudinal self-regulation studies that find a rapid period of development over the first few years followed by increasing levels of stability (Colman et al., 2006; Ostrov et al., 2013; Rothbart et al., 2001; Sanson et al., 2009).Within-time cross-construct correlations were relatively low, with the exception of sleep and emotional regulation during infancy. This reflects other research findings which indicate infant sleep regulation to be correlated with more positive temperament typologies (Spruyt et al., 2008). The remaining low within-time correlations in this study appear to reflect an increasing relative independence of sleep, emotional and cognitive regulation from the age of 2 years.

The findings make an important contribution to contemporary and growing evidence that sleep may have an important role to play in the development of higher order cognitive functions and self-regulation as a whole (Bernier et al., 2013; Bernier, Carlson, Bordeleau et al., 2010). Sleep regulation at 2-3 years predicted emotional regulation two years later, over and above the influence of prior levels of emotional regulation. Emotional regulation consistently predicted cognitive regulation two years later, even when prior levels of cognitive regulation were controlled for. This pattern seems to suggest a developmental cascade whereby poorer sleep regulation is related to increasing levels of emotional reactivity which is in turn related to decreasing performance on cognitive regulation measures. Children who are unable to regulate their own sleep during the night might have lower coping capacity for everyday interactions or frustrations during the day. An increase in highly reactive behaviour is likely to lead to a child not being able to capitalise on opportunities for cognitive and attentional development.

The analyses presented in this thesis offer new insight into the relative contribution of each aspect of self-regulation in relation to ongoing regulatory capacity and later behaviour problems for children, and mental health problems for mothers. Children's self-regulatory abilities measured at 2-3 years emerged as a consistent predictor of future outcomes. It was at this point, rather than during infancy, that emotional and cognitive regulation became predictive of behaviour problems four years later. It was also at this point that children's emotional regulation began to exert an influence on maternal mental health. These findings were in spite of the fact that the prior level of emotional regulation, as measured in infancy, was accounted for. Taken together with the increasing stability of the self-regulation indicators evident from this same age point, it appears that the period from birth to 3 years represents an important period in which to consider addressing temperamental and maternal risk. The longitudinal profile analysis presented in this thesis suggests that for approximately 30% of Australian children, early self-regulation problems may become entrenched. Addressing temperamental and maternal risk early in life might reduce the risk of persistent self-regulation problems and the consequent risk for later behaviour problems.

This thesis documents for the first time the normative developmental pathway for multiple-domain self-regulation in young Australian children. Importantly, the findings indicate that deviation from a normative pathway is characterised by infant sleep problems that do not resolve over the first five years. The normative developmental pathway for self-regulation in Australian children appears to be characterised by consistently improving sleep, emotional and cognitive regulation across the first five years. In fact, children in the normative profile (69% of the sample) had no persistent parent-reported sleep regulation problems at 4-5 years. Children likely to have a profile of ongoing self-regulation problems were able to be identified during infancy by their significantly lower capacity to regulate their own sleep and higher levels of emotional reactivity. These children (approximately 30%

of the sample) had an increase in mother-reported sleep problems over the five years and tended to also show decreasing levels of emotional and cognitive regulation. A related finding from recent sleep research found that sleep problems occurring between 2 and 4 years of age, but not during infancy, were predictive of persistent attention regulation problems from 5 to 14 years of age (O'Callaghan et al., 2010). These authors highlight the need for health practitioners to be particularly concerned with reports of sleep problems still occurring in preschool children and that addressing these may be crucial in supporting growth in cognitive regulation for these children. The findings of this thesis support this view.

8.3.3 Prevalence rates of early childhood self-regulation problems in Australian children

This study is the first to document a prevalence rate for mother-reported self-regulation problems in Australian children that span the early childhood period. Results indicate that a total of 31% of Australian children aged under 5 years experience sustained self-regulation problems across sleep, emotional and cognitive domains as evidenced by membership of one of the two poorer self-regulation profiles. The findings add Australian evidence to the body of research that identifies such self-regulation problems to be predictive of later social, emotional and behavioural problems.

The prevalence of sleep problems in infants and young children is widely reported. While prevalence estimates vary substantially due to different methodologies for measuring and categorising sleep problems, they typically align with the 31% self-regulation problem prevalence estimate found in the current study. For example, Quach and colleagues (2012) have reported rates of parent-reported sleeping problems in Australian children to be 34% for 4-5 years olds. Studies that use both actigraph (objective) and parent-report (subjective) measures of sleep problems in children tend to estimate sleep problem prevalence rates as higher than studies that use subjective measures only. Parent-report alone is likely to underestimate sleep disturbance in children due to the frequency of actigraph-recorded night wakings that parents are unaware of due to children not signalling (Tikotzky & Shaashua, 2011). Given this, it is possible that the prevalence rate of 30% reported in the current study may be an underestimation of sleep and other self-regulation problems in Australian children. There may be a degree of night-waking or restless sleep occurring in children that parents are unaware of and thus did not report in the current study.

Prevalence estimates for emotional and cognitive regulation problems in young children are much harder to find and interpret due to the wide range of measures used in research, and the variety of ways that regulation ‘problems’ are defined. One highly relevant study from the Australian context is that of Sanson and colleagues (2009) as part of the *Australian Temperament Project* from which the LSAC temperament measures were derived. These researchers used profile analysis to explore the temperament typologies of children aged two- to four-years-old. They report two profiles with characteristics pertaining to self-regulation difficulties. The poor attention regulation group (27.8%) were characterised by poor cognitive and moderately poor emotional regulation. The reactive group (20.4%) had poor emotional regulation and moderately poor cognitive regulation. This equates to almost half of the sample in that study exhibiting problems with self-regulation during this period of early childhood. This is a higher rate than found in the current study (31%) and thus again points to the possibility that the prevalence rate in the current study may be an underestimation, or at least a conservative estimate.

The prevalence rates of social, emotional and behavioural problems found in this study compare as would be expected with others reported recently. Specifically, broadband problem scores on the *Strengths and Difficulties Questionnaire* (SDQ; Goodman, 2001) have been reported in 12% of the LSAC Kindergarten Cohort at 4-5 years of age (Davis, Sawyer, Lo, Priest, & Wake, 2010). Although these data are not directly comparable due to the differing ages of children involved (children were 6-7 years in the current study), children in the normative self-regulation profile found in this thesis had a substantially lower rate of problem broadband scores (9.8%) and those in the very poor self-regulation profile had a substantially higher rate of broadband scores (20%) than the 4-5 year old Australian population sample (12%). In addition, the sample mean for the LSAC B-Cohort on the SDQ Total Problems Score (8.5) is substantially higher than the normative self-regulation profile mean (7.2) and lower than the very poor profile (9.6) as would be expected (Baxter, Gray, Hand & Hayes, 2013). These comparisons confirm that the early childhood self-regulation profiles established in this research were successful in identifying those children with substantially higher than normative amounts of behaviour problems at 6-7 years based on their sleep, emotional and cognitive regulation across birth to 5 years.

8.3.4 Early childhood self-regulation and later behavioural problems

The results of this program of research document the particular time points in early childhood in which specific aspects of self-regulation contribute most substantially to later behavioural outcomes for children. Results are strengthened through the use of a longitudinal panel modelling approach and analysis of both mother- and teacher-reported behavioural outcomes. Both mother- and teacher-reported behaviour problems were predicted by emotional regulation at 2-3 and 4-5 years and cognitive regulation at 4-5 years. In addition, cognitive regulation at 2-3 years predicted mother-reported behaviour problems, but not teacher-reported. Longitudinal profile membership was able to predict later mother-reported behaviour problems, but was not predictive of teacher-reported behaviour problems. These findings generally concur with those found in the existing body of research where poorer self-regulation skills are associated with higher rates of later behaviour problems (Kim & Deater-Deckard, 2011; Olson et al., 2011; Ramani et al., 2010).

The use of both mother- and teacher-reported behaviour problems added methodological strength to the analyses. Support for the predictive validity of mother-reported child regulation in relation to teacher-reported behaviour problems *as well as* mother-reported problems was particularly important. If this was not the case, a significant methodological weakness would be apparent because of the suggestion that mothers' negative views of their children continued to influence their ratings of their behaviour over time, contributing to shared method variance. The inclusion of teacher-reported data also provided additional information on children's behaviour in a context that differs from the home environment. Typically classrooms have more specific rules and greater structure around behaviour than home environments. In the current study the correlation between mother- and teacher-report of behaviour problems was typically modest (Mieloo et al., 2012). Teachers rated children overall as less problematic in their behaviour than parents, a trend also found in the LSAC K-cohort (Davis et al, 2010).

The extent to which self-regulation measured at different time periods during the first five years was useful in predicting later behaviour problems is worthy of further discussion. Measures taken in infancy did not predict later outcomes. The predictive power of emotional and cognitive regulation began at 2-3 years and generally increased over time, with additive effects shown by the number of significant indirect pathways stemming from these self-regulation indicators at this time. Importantly, self-regulation at 2-3 years directly and uniquely predicted behaviour problems four years later, even though self-regulation in the intervening time period of 4-5 years was included in the model. In combination with the results that indicated that stability in self-regulation skills appears to increase over time, these findings suggest key periods for growth and development in self-regulation. The period from birth to 3 years, where these traits are less stable, may be a window of opportunity to effect change in the early self-regulatory characteristics of children, particularly in relation to emotional regulation. However, additional development of self-regulatory abilities across the early years is also likely to also have important effects in relation to later outcomes.

Changes in the ability to self-regulate across the early years appear to also be very important as highlighted by the longitudinal panel models which controlled for prior levels of each of the self-regulation indicators. Emotional and cognitive regulation at 2-3 and 4-5 years predicted later behavioural problems even when prior levels of these skills were controlled for. The relationship between self-regulation at 2-3 years and behavioural outcomes four years later was partially mediated by self-regulation in the intervening time period of 4-5 years. Cognitive regulation at 2-3 years alone was not directly predictive of teacher-reported behaviour problems, but cognitive regulation at 4-5 years was. This indicates that changes or growth in emotional and cognitive regulation from 2 to 5 years are an important consideration in the development of behaviour problems in the early school years. Similarly, it was growth in sleep regulation skills over the first five years that distinguished the normative self-regulation profile group from the poorer groups. These findings reflect the work of others who have confirmed that growth in self-regulatory abilities uniquely predicts growth in other developmental areas, such as academic skills, over and above prior levels of self-regulation (Welsh, Nix, Blair, Bierman, & Nelson, 2010).

These findings make a significant contribution to understanding of the role of sleep in early childhood self-regulation development. They establish that sleep problems that extend beyond the infant years are important indicators of broader self-regulatory problems and they also provide evidence for the role for sleep in the ongoing development of other areas of self-regulation. For instance, in this study, sleep regulation during the third year predicted emotional regulation during the fifth year which, in turn, was a consistent predictor of both mother- and teacher-reported behaviour problems. Sleep regulation did not directly predict behaviour problems but exerted an influence through these indirect paths only. These findings provide some support for recent contentions that sleep plays a role in the development of higher order self-regulatory abilities in young children (Bernier et al., 2013). Recent reports also indicate that infant sleep problems are not predictive of child outcomes at 6 years of age (Price, Wake, Ukoumunne, & Hiscock, 2012), but sleep problems in the preschool years are (Quach et al., 2012). The relationship between declining sleep regulation in the poor self-regulation profiles and later behaviour problems in the current study seem to support this view. Taken together, these findings reinforce the recent recommendations by others that health practitioners should pay particular attention to child sleep problems reported beyond the early infant period (Price et al., 2012).

Theories on the mechanisms through which early self-regulation influences later behavioural problems relate to the contributions that aspects of self-regulation make within children's developmental pathways. Optimal regulation and integration of cognitive and emotional processes in children leads to a set of skills and environmental reinforcements that are likely to contribute to a decreased risk of social, emotional and behavioural problems. These skills include the ability to inhibit impulsive responses, to redirect attention to less negative aspects of the environment, to attend to opportunities for social learning, to implement effective emotional regulation strategies when things go wrong and to better empathise and communicate emotion with social partners (Blair et al., 2013; Belsky et al., 2007; Kim & Deater-

Deckard, 2011; Morris et al., 2010). These skills lead to children behaving in ways that stimulate praise from parents and teachers, leading to the child developing a positive self-perception which contributes to ongoing positive social, emotional and behavioural development (Blair & Diamond, 2008). Alternatively, children who do not develop these skills may experience a negative feedback loop in relation to parents, teachers and peers, resulting in them being at increased risk for the kinds of problems identified by the outcome measure in the current study.

A final important mechanism to consider regarding the role of self-regulation relates to the mediating role it plays in the relationship between early risk and later outcomes. Although not a focus of the current program of research, the current findings indicate that early childhood self-regulation mediates the relationship between socio-economic disadvantage and later outcomes. These findings confirm other recent research that has found evidence for the buffering effect that self-regulation skills provide children in the context of environmental risk (Dilworth-Bart, 2012; Derauf et al., 2011). Taken together with the extent to which early self-regulation was able to predict later behavioural problems for children in the current study, these findings again reinforce the importance of intervening early to support emerging self-regulatory abilities in young children.

8.3.5 Self-regulation in early childhood and maternal mental health: Bidirectional relationships

The second study presented in this thesis represents a unique and important contribution to new knowledge in the area of transactional theories of child development where evidence for child-driven effects is often hypothesised but rarely found. In this thesis, contemporary statistical modelling was used to sequentially test the hypothesis that both mother- and child-driven effects are at play in relation to children's early self-regulation and maternal mental health. The results confirm this hypothesis and thus represent the first empirical evidence, to the author's knowledge, to support these complex transactional processes between early childhood self-regulation and maternal mental health.

A history of significant maternal depression (lasting for a period of two years or more prior to the initial data collection time point) predicted poorer sleep and emotional regulation in infants and 2-3 year olds and more behavioural problems at

6-7 years. Poor maternal mental health (assessed by the Kessler 6) during infancy predicted poorer emotional and cognitive regulation two years later and poor maternal mental health at 2-3 years predicted poorer emotional regulation at 4-5 years. These findings concur with other studies that have found prenatal maternal depression to be associated with poor infant sleep regulation very early in life (Armitage et al., 2009; Field et al., 2007) and maternal stress in infancy to be related to lower levels of attentional and emotional regulation at age 5 (Pesonen et al., 2008). It is interesting to note that the predictive power of maternal mental health in relation to later self-regulation for children tended to decrease over time. It may be that the effect of maternal mental health on children's developing regulation skills is somewhat complete by the age of 3 years, the same time point from which higher degrees of stability in self-regulation were found. Future research should test this hypothesis further.

Important and unique evidence for child-driven effects of self-regulation on maternal mental health emerged from 2-3 years of age. At this point, children's emotional regulation predicted maternal mental health two years later and this pattern continued with children's emotional regulation at 4-5 years predicting maternal mental health another two years later. These findings are not directly comparable to any other previous studies found as no others have specifically explored the bidirectional effects occurring between child self-regulation and maternal mental health. In related work, evidence was been found for the bidirectional effects between maternal depressive symptoms and children's behaviour problems (Bagner et al., 2013), and parental stress and behaviour problems (Neece et al., 2012) across the period from 3 to 9 years. Others have found evidence that children's temperament and behaviour influences parental use of teaching strategies and behaviour management techniques (Barnes et al., 2013; Belsky & Park, 2000; Eisenberg et al., 2010). Still others have tested for bidirectional effects but found either no evidence for child-driven effects or have found them only for a particular subset of participants (Choe, 2012; Pesonen, 2008), or only cross-sectionally but not longitudinally (Verhoeven et al., 2010).

The pattern of findings in the current study is suggestive of a mutual exacerbation process occurring within the mother-child system across the early years.

The mutual exacerbation hypothesis is an extension of transactional theories of child development (Lorber & Egeland, 2011). It posits that negative parenting in combination with negative child attributes (such as poor self-regulation) mutually exacerbate each other. Children with poorer self-regulation skills might elicit parenting practices that put children at risk for ongoing behaviour problems. Mothers who use mostly negative parenting practices might elicit the kinds of negative child behaviours that are likely to put mothers at risk of further negative parenting. To date this hypothesis has primarily been tested in relation to temperament, negative parenting behaviours and the development of conduct problems (Lorber & Egeland, 2011), but not in relation to mental health.

It is important to note that both mother-driven and child-driven effects held even though prior levels of maternal mental health and the self-regulation indicators were accounted for in the models. This suggests that these findings are robust and effect sizes are conservative. It also indicates that *changes* in maternal mental health are important predictors of *changes* in children's self-regulation over time and vice versa. This reflects findings by Nicholson and colleagues (2011) who studied adolescent mothers and their children aged 3 to 10 years. They found that as maternal depressive symptoms became more or less severe, so too did child behavioural problems (Nicholson, Deboeck, Farris, Boker, & Borkowski, 2011). Taken together with the findings of this study, these indicate that if interventions or parenting support are successful at making positive changes in *either* maternal mental health or children's self-regulation skills, then there will likely be benefits for both members of the mother-child dyad.

8.3.6 The role of parenting in the path between early self-regulation and later behavioural outcomes

The research presented in this thesis contributes new evidence for the role of parenting in children's self-regulation development. While it is generally accepted that positive parenting styles support positive child development, prior studies in the self-regulation area have found mixed results. Taken together these suggest complex relationships exist between various aspects of parenting and children's self-regulatory capacity (Blair et al., 2013; Brown, 2010; Degnan et al., 2008; Higgins, 2008; Nelson et al., 2012; Razza et al., 2012). The program of research conducted for this thesis therefore took an exploratory approach by selecting seven measures of maternal parenting and mental health available in LSAC and testing them as both moderators and mediators of the relationship between early self-regulation and later behavioural problems.

Maternal mental health, self-efficacy, parenting anger and hostility were found to be significantly involved in the relationship between early self-regulation and behaviour problems. Broadly stated, emotional and cognitive regulation at 2-3 years was associated with higher maternal self-efficacy, lower levels of parenting anger and better maternal mental health at 4-5 years which in turn were associated with less behaviour problems in children at 6-7 years. These relationships were also found when parenting mediators of the relationship between overall early childhood self-regulation typology (the latent profiles) and later outcomes were examined. In addition, children who were members of the poorer self-regulation profiles also contributed to higher levels of maternal parenting hostility at 4-5 years of age which contributed to higher levels of behaviour problems two years later. These findings were consistent across analyses that variously used toddlerhood emotional and cognitive regulation, and self-regulation typology as predictors, suggesting the findings are robust. The findings also reflect other similar work in the field (Paulussen-Hoogeboom et al., 2008; Van der Bruggen et al, 2010).

It is interesting to note that the important mediators in this study can be grouped into two main areas: positive mental health (maternal mental health and parenting self-efficacy) and negative parenting practices (anger and hostility). Three other measures related to positive parenting practices were tested as mediators (consistency, warmth and inductive reasoning), but significant relationships did not emerge. This is somewhat in contrast to the majority of research to date which finds the presence of positive parenting practices such as sensitivity, emotional socialisation and warmth to be key supports in self-regulation development (Blair et al., 2013; Perry et al., 2013; Spinrad et al., 2012). Fewer studies focus on negative parenting practices with emergent results tending to support the findings of the current study. For example, Barnes and colleagues (2013) found poor self-regulation skills in two-year-old children to predict higher levels of spanking and behaviour problems two years later. In the current study, the lack of significant findings in relation to positive parenting may be related to limited measurement of these constructs. However, persistent identification of negative parenting practices as important in children's self-regulation development warrants further discussion.

One interesting consideration is the extent to which the items that measured parenting anger and hostility actually reflect something about mothers' own capacity for self-regulation. These items asked mothers to rate how often they had lost their temper or raised their voice to a child or felt angry when punishing a child. Maternal responses on such items might reflect the extent to which mothers have the capacity to emotionally regulate themselves. If this proposition is accepted a number of interesting theories for future testing arise.

First, there may be heritability of temperamental self-regulation at play within the mother-child dyad or learned behaviour passed on from parents. Mothers with poorer self-regulation skills (reflected by higher levels of parenting anger and hostility) might have passed on a genetic vulnerability to poor self-regulation to their children and may also model behaviours indicative of poor self-regulation. Studies that support this view include those that have identified specific genes associated with self-regulation (Kochanska et al., 2009; Sheese et al., 2009) and those that find parental self-regulation to predict children's self-regulatory behaviours (Bridgett et al., 2011).

Secondly, the mutual exacerbation process described in the previous section might also apply in regards to poor self-regulation in children and negative parenting behaviours. Children who do not develop expected capacities to self-regulate across the first two to three years might stimulate levels of stress in mothers, particularly in those who are already vulnerable to mental health and self-regulation difficulties. As mothers' psychological resources are stretched, both by the natural challenges that parenting a toddler presents, as well as their child's unique self-regulatory capacity, their ability to employ self-regulation skills themselves might be compromised. This decreased capacity for self-regulation in parents might present itself through increased angry and hostile interactions with children.

Finally, leaders in the parenting intervention field have recently discussed the fact that positive parenting requires a good deal of self-regulation on the part of parents and that for parenting interventions to be effective they need to focus on these skills in parents (Sanders & Muzzucchelli, 2013). This view provides support for the notion that negative parenting styles might be indicative of poor self-regulation in parents. Future research should examine the extent to which measures of parenting anger and hostility reflect individual differences in parental self-regulatory capacity and the ways in which parental self-regulation influences and is influenced by child self-regulatory capacity across time. Future efficacy studies should investigate the degree to which interventions which result in positive changes in parental self-regulation also have beneficial effects for children's self-regulatory abilities.

The findings in this study that only maternal mental health and negative parenting practices were important mediators of children's self-regulation has significant implications for parenting support practices. In some ways these results challenge the premise on which many parenting support interventions are designed, which is to up-skill parents in positive parenting practices such as consistency, inductive reasoning and warmth (Roberts, Mazzucchelli, Studman, & Sanders, 2006). The findings of this study suggest that it may be the *removal* of negative parenting practices and supporting parental self-regulation, self-efficacy and mental health that might have the greatest impact in terms of reducing the risk that children with self-regulation problems will go on to develop behaviour problems. While parental support that encourages positive parenting practices might also reduce negative parenting practices as a related result, research on parenting interventions that aim to primarily support parental emotional self-regulation, thereby reducing harsh and angry parenting would be valuable. The consistent ways in which maternal mental health and self-efficacy emerged as important mediators that are both influenced by and exert an influence on regulatory and behaviour problems in children implicate these areas as critical considerations in parental support.

8.4 Research Limitations

While this program of research represented a number of strengths in relation to the sample and methodology, a number of limitations have also been identified throughout the thesis. These included a lack of longitudinal measurement invariance, the use of only maternal report which contributes to shared method variance, and the lack of controlling for prior levels of variables in some of the mediation models. Many of these limitations are related to the pitfalls of secondary data analysis. These include being limited to the measurement instruments included in the original study design, which may, in the interest of efficiency and brevity, be shortened and adapted versions of original validated measurement, and may also change over the course of the developmental period being studied (Friedman, 2007; Hofferth, 2005). However, it is important to recognise the opportunity that such secondary data analyses present. These include the ability to efficiently address a research question that may have otherwise been prohibitively expensive and time consuming (Hofferth, 2005). In the current case, access to such a large national dataset also provided the opportunity for the candidate to learn and apply contemporary statistical techniques not appropriate in smaller sample sizes.

While many limitations apply, the findings from such analyses can be viewed as important building blocks for the development of future studies which aim to examine particular developmental processes in more detail with more robust and comprehensive measures. The discussion of limitations presented throughout this thesis has important implications for the design of future studies. These have been noted throughout the thesis and include implementing multi-method multiple-informant designs wherever possible and considering the impact on analyses of having measures that change substantially in their nature across time.

The sample selection procedure in the current study also limits the extent to which findings can be generalised. Although the LSAC dataset is population-representative, the initial list-wise deletion of participants who did not have complete data on the variables of interest altered the nature of the sample. The mothers and children selected for this study were less likely to be Indigenous and have a main language other than English. These differences between the selected sample and those not included are typical of the patterns of losses experienced in longitudinal studies, and mean that the participants in this study are no longer representative of the full LSAC study and the Australian population. The study findings are therefore not generalisable to the population as a whole and should be interpreted with this in mind. Future research should address this issue by seeking to include participants from these cultural backgrounds.

The *Footprints in Time: The Longitudinal Study of Indigenous Children (LSIC)* dataset represents an opportunity to examine similar research questions in a group of participants who identify as Aboriginal or Torres Strait Islander. Recent work with this dataset examined the measurement properties of some of the same scales selected to represent emotional and cognitive regulation in the current research (Little et al., 2012). These authors found that the measures behaved significantly differently in the LSIC dataset when compared to the LSAC dataset. This suggests that replication of the analysis methodology presented in this thesis will not be possible. Alternative approaches will be needed to address similar research questions in LSIC and future research should explore ways in which to do this.

A final and important limitation of this study is the inclusion of only mother-reported data on children's self-regulation and the investigation of only maternal parenting and mental health. Recent analyses using the LSAC dataset highlight the important role that paternal behaviour has in promoting self-regulation skills in young children (Williams & Berthelsen, 2013). It is also clear that fathers as well as mothers, experience heightened risk of mental health difficulties postnatally (Giallo et al., 2012) and paternal mental health difficulties influence child behaviour problems (Giallo, Cooklin, Wade, D'Esposito & Nicholson, 2013). These suggest that a similar transactional process may operate between fathers and their children and thus further analyses on the transactional relationships among children's self-regulation and paternal mental health and parenting behaviours should also be conducted to better elucidate the role of both mothers and fathers in children's self-regulatory development. Future research should include paternal report of children's self-regulation skills which would provide additional strength over studies such as the current one which uses only a single-rater measure.

8.5 Policy and Practice Implications

The early childhood policy environment in Australia is characterised by growing cross-departmental recognition of the importance of the early years (Council of Australian Governments, 2009). This has resulted in an initiative aimed at identifying developmental vulnerabilities in children at the community level as they enter the first year of school (*Australian Early Development Index*; Australian Government, 2013), as well as policy designed to address early development through increased preschool participation (Council of Australian Governments, 2009). Despite these initiatives, clear gaps in children's developmental competencies and school achievement levels persist (Nicholson, Lucas, Berthelsen, & Wake, 2012). A greater understanding and widespread awareness of the most important developmental mechanisms that contribute to positive outcomes for children may inform more targeted and effective policy and practice that aims to minimise these developmental inequalities.

The research reported in this thesis contributes in a substantial way to the Australian policy and practice context by establishing a case for increased recognition of self-regulation as an important consideration in early childhood. The findings confirm that mother-reported self-regulatory capacity in early childhood is an important predictor of social, emotional and behavioural outcomes in the early school years, as well as maternal wellbeing. The analyses used contemporary and robust statistical methodology with data from a large Australian dataset and therefore the results hold unique relevance to the Australian context. With currently only one early childhood education policy or curriculum document specifically noting the ability to self-regulate as a key skill required for optimal functionality (the *Early Years Learning Framework*; Australian Government Department of Education Employment and Workplace Relations, 2009), the dissemination of these results is timely. Recent media attention for related work which predicted early school prosocial behaviours from toddlerhood self-regulation suggests that there is a degree of public interest in this area and also served to raise awareness of self-regulation (Viellaris, 2013). Careful and ongoing dissemination of the findings will be important and as such a plan for this has been devised and can be found in Appendix I along with a list of research outputs to date.

The research findings pose important implications for postnatal support, early parenting interventions and early childhood education and care practices by suggesting that self-regulation should be a key focus of practice. Typically, early intervention efforts in Australia focus on families considered socially at risk or disadvantaged, with risk indicators such as being of minority status, lower socio-economic status or single parenthood used to identify these families (Australian Government Department of Families Housing Community Services and Indigenous Affairs, 2011). While these elements remain of great importance, this thesis presents evidence that children with early indicators of self-regulatory problems should also be considered as an 'at risk' target group. These children are more likely to have behaviour problems in the early school years and are also likely to contribute to poor maternal mental health across time. Just over 30% of the participants in this study were identified as having self-regulation problems which were significant and persistent across the first five years.

This thesis contributes new evidence for the validity of using short parent-report measures in identification of this 'at risk' group in screening procedures. Effective screening has been described as using high sensitivity but low specificity measures in order to identify individuals with a potential problem (Bagner, Rodriguez, Blake, Linares, & Carter, 2012). Screeners also need to be brief in order to be able to be administered to a large number of individuals at once and are distinguished from assessments which are more thorough and specific and often carried out as the next step following screening (Bagner et al., 2012). The findings of this study indicate that short parent report of children's behaviour in relation to sleep, emotional and cognitive regulation could be developed into useful screeners of self-regulatory problems. Parents who report sleep problems that extend beyond the early infant years, and in fact deteriorate could be considered a particular at risk group.

This study also has significant implications for parent education by documenting the normative typology for early childhood self-regulation in Australian children and establishing the indicators that would suggest to parents that their child is not within this normative range. The normative pathway is characterised by consistently higher emotional and cognitive regulation abilities than the poorer regulation pathways, and improving sleep regulation such that no persistent sleep problems are reported by parents at 4-5 years of age. Parents seeking to ascertain the extent to which their child's behaviour is within the 'norms' of developmental expectations might benefit from this information. In particular, sleep regulation problems that do not gradually resolve across the first five years, while not uncommon (31% did not resolve), do represent a departure from the normative developmental pathway. If parents are more aware of these norms they may be more encouraged to seek support to address early sleep regulation issues which may contribute to other, more widespread positive outcomes across time.

The current research findings also contribute important information about which behaviours, at which time in family life, would be best targeted by preventative and early intervention approaches. First, mothers with a significant history of depression are a particular at risk group. They appear more likely to have children with self-regulation problems, and may be more susceptible to the mutual exacerbation processes that result in increased risk for ongoing mental health problems and later behaviour problems for children. Effectively treating maternal depressive symptoms pre and postnatally would likely have beneficial effects for the mother-child dyad and developmental processes across time. In addition, mothers with a known history of depression who report finding their child's self-regulation to be posing a problem in the mother-child relationship should be given priority for additional support.

Second, addressing sleep regulation issues for children at a young age is a key issue. The evidence in this study suggests that sleep regulation has ramifications for the development of later emotional regulation in children and in turn, cognitive regulation, behaviour problems and maternal wellbeing. While evidence for the efficacy of interventions to directly address emotional regulation in young children is scarce, interventions that address infant night waking have been effective in not only improving infant sleep regulation but also reducing maternal depressive symptoms (Hiscock & Wake, 2002). Interventions that aim to resolve sleep problems and address maternal mental health prior to 3 years of age may be particularly important. There appeared to be a greater degree of malleability in children's self-regulation skills during this time with stability increasing from 3 years of age. Child-driven effects were also yet to emerge and as such, intervening effectively at this stage, before self-regulation problems have become embedded and begin to exert a deleterious effect on maternal mental health could be critical.

Third, supporting emotional regulation in both children and parents across the early years is indicated as a key consideration for practice. Infants who are highly reactive are likely to test the parenting capacity, mental health and self-efficacy of mothers. When these psychological resources are taxed, parents might struggle to emotionally regulate themselves leading to more instances of negative parenting. Early parenting programs that assist parents to best scaffold developing emotional regulation in their children while simultaneously addressing parents own need for psychological support could be highly beneficial. The findings of this study suggest that this kind of support should be available from very early in life and at least from the second year. At this point normative infant patterns of night-waking have somewhat settled and children's individual levels of emotional reactivity are more clearly evident. Child-driven effects of poor self-regulation on maternal mental health have yet to emerge, as has the predictive value of mother-reported self-regulation in relation to later school behaviour problems. Changes in the parenting environment and children's self-regulatory capacity made prior to 2-3 years are therefore likely to have substantial positive long-term effects.

Fourth, the evidence from this study suggests that the period from 2 to 5 years of age may represent a window of opportunity for making key changes in children's ability to regulate their attention. Cognitive regulation at 4-5 years (but not two years earlier) was an important predictor of early school problems as well as a key mediator in the relationships between early self-regulation measures and later behavioural problems. This suggests that efforts to improve children's cognitive regulation from 2 to 5 years of age might have substantial benefits. Cognitive regulation was only moderately stable across this time and so the capacity for change is clearly present. It is at this time that many children are entering early childhood education and care settings and so educators, as well as parents, have a role to play in identifying children who struggle with self-regulation and addressing these skills.

Finally, the study results suggest that changes that can be made in *any* of the self-regulatory domains or in maternal mental health at *any point* in the first five years are likely to contribute to a buffering effect for children in relation to the development of later behaviour problems. This is of particular note given that many early parenting supports focus primarily on the immediate postnatal period.

However, there is a normative spike in children’s emotional liability and oppositional behaviour that occurs during the toddler years. In addition, the current research has shown that at this time child-driven effects on maternal mental health emerge, and the predictive ability of children’s self-regulation in relation to later school outcomes strengthens. It would seem then that failing to continue to support parents during the toddler years presents a missed opportunity to alter the developmental course for children in a positive way.

Taken together these findings suggest that there are at least two potential agendas to be pursued in relation to self-regulation intervention. First, a number of early intervention and prevention efforts, including early parenting support or particular early education and care experiences, may already be exerting positive benefits on children’s self-regulatory capacities but these are not being measured or reported. Second, the development of prevention and intervention efforts that specifically and effectively address self-regulation skills in children is still very much in its infancy. To the author’s knowledge there are no Australian programs specifically designed to address children’s self-regulation and related parent education and support and thus this is a clear avenue for future practice and research efforts.

8.6 Conclusions

A rapidly growing body of research has identified self-regulation skills as critical to success and wellbeing across the lifespan. The ability to self-regulate behaviour, emotions and cognition develops rapidly in the early years and is in part biologically driven and in part developed through experience. An understanding of the developmental pathway of self-regulation in very young children is essential if education and family support systems are to have maximum impact during the early years.

This research is the first to explore the self-regulation of Australian children longitudinally using a large national dataset and as such it makes a substantial contribution to understandings of this important construct. Key findings include evidence for the validity of using short parent-report measures of sleep and temperament from birth to 5 as indicators of children’s self-regulatory capacity which predict risk for the development of later behavioural problems. Sleep regulation was identified as a key factor that both contributed to the development of overall self-regulation and distinguished those children exhibiting a non-normative developmental trajectory. In unique and important analyses, this study also detailed the mother- and child-driven effects associated with children's self-regulation and maternal mental health. These factors appear to mutually exacerbate each other leading to heightened ongoing risk for the mother-child dyad. Finally, this research is the first of its kind to describe the normative developmental pathway for self-regulation in Australian children which is characterised by improving sleep regulation up to 5 years and consistently better emotional and cognitive regulation skills compared to other children. Just over 30% of Australian children appear to experience sustained early childhood self-regulation problems characterised by declining sleep regulation across the first five years. These children are at heightened risk of behaviour problems at school and may contribute to poorer mental health for mothers. An absence of negative parenting and positive mental health and self-efficacy in mothers was found to act as a protective factor for these children.

The results are of interest to policy makers, parents, early childhood practitioners and early intervention designers. If future policy drivers and intervention efforts seek to target the factors that best support optimal development for all children then self-regulation must become a more critical consideration in these arenas. Children with poor self-regulation skills should be identified by parental report of sleep problems that extend beyond the infant years and poor emotional and cognitive regulation. Mothers who have a history of depression are also an important risk group. Family supports that address approaches to encouraging sleep regulation in young children may be particularly beneficial. Continuing to support parents in the challenging toddler years is also indicated as self-regulation problems appear to become embedded at this time and children's self-regulation begins to affect maternal mental health. Addressing early self-regulation in children, along with bolstering parental mental health and positive parenting should contribute to reducing the gap in developmental competencies evident in Australian children at school entry. Addressing this gap prior to school entry is a crucial endeavour for the early childhood education and care agenda as only by doing this can all children be provided with the best possible chance of succeeding across their schooling careers.

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APPENDIX A SYSTEMATIC LITERATURE REVIEW PROTOCOL

1 Aims and focus questions

The aims of the review are to:

- Identify studies examining self-regulation and associations with parenting and social outcomes in children aged up to seven years old
- Identify the ways in which self-regulation is conceptualised and measured from birth to age five

The focus question for the review is:

How are children's self-regulation skills longitudinally and reciprocally related to parenting behaviour and mental health, and children's social, emotional and behavioural outcomes?

2 Search strategy

The search strategy will use electronic databases, internet searches, reference list reviews, key author searches and key journal reviews.

Electronic databases

- PsychInfo via EBSCO HOST
- ERIC via EBSCO HOST
- Australian theses via Trove (National Library of Australia)
- Proquest Psychology and Proquest Dissertations and Theses
- Cochrane library
- Campbell collaboration

Search terms

Initial broad reading lead to the development of the following potential search term matrix.

CHILD ID	SELF-REGULATION	PARENT ID	PARENTING	PARENT MENTAL HEALTH	OUTCOMES
Child* OR Infan* OR preschool* OR toddler OR kindergarten	Self-regulation "regulatory problems" Regulation Hyperactiv* Persistence Distractibility Sleep* Eating or feeding Effortful control Executive attention Attentional control Inhibitory control Activation control Regulatory capacity Executive function	Mother* OR Parent*OR maternal OR father* OR paternal	Sensitive* Warm* Responsive* Style Behaviour* or behavior* Hostil* Consistenc* angry	coping efficacy Depress* distress "mental health" adjustment	Adjustment Behav* Social Emotion* conduct Mental health

Three possible search strings for electronic databases were trialled before the final search string, listed below, was identified as yielding a manageable number of highly relevant results.

(Child* OR Infan* OR preschool* OR toddler* OR kinder*) AND (Self-regulation OR "regulatory problems" OR regulation) AND (Mother* or parent* or maternal) OR (adjustment, behave* or social or conduct or "mental health") AND Longitudinal or prospective

The search string will be used in 'all text' unless more than 500 items result. In this case the search string will then be searched in either 'abstract' or 'key words'.

3 Inclusion criteria

To be included in the review, studies must meet the following criteria

- Be published from 2006 to present, however key studies from prior years, cited in papers found in primary search will also be included.

- Include at least one measure of child self-regulation with at least one point of data collection being within the first five years of life
- Be longitudinal in nature (at least 2 time points of measurement)
- Include at least one measure of an aspect of parenting or parent mental health OR child social / emotional / behavioural adjustment along with self-regulation

Exclusion criteria

- Cross-sectional design
- Outcome variable of interest is NOT related to social, emotional and behavioural constructs (e.g., is related to academic outcomes)
- Has a sole focus on special populations (e.g., children with disabilities, children born pre term, highly socially disadvantaged groups, minority groups)

Exception criteria

- Studies that are focussed on a non-normative sample, where the sampling focus is related to the outcome of interest (i.e., social, emotional and behavioural adjustment).

4 Search diary (2006 – 2011)

Database	Date searched	Search string used in field...	No. Identified	No. Accepted
ERIC	090811	all text	56	0
Psychinfo	090811	all text	303	23
Proquest psychology	120811	abstract	49	3
ProQuest Dissertations	120811	abstract	87	1
Cochrane library	120811	all text	140	0
Campbell Library	120811	all text	0	0
National library of Australia – theses	120811	key words	38	2
TOTAL			**332**	**29**

Search diary (August 2011 – August 2013)

Database	Date searched	Search string used in field...	No. Identified	No. Accepted
ERIC	080713	all text	21	1
Psychinfo	100713	all text	180	15
Proquest psychology	100713	abstract	24	1
ProQuest Dissertations	100713	abstract	19	4
Cochrane library	100713	all text	87	0
Campbell Library	100713	all text	0	0
National library of Australia – theses	100713	key words	18	0
TOTAL				**21**

APPENDIX B SUMMARY OF PAPERS INCLUDED IN THE SYSTEMATIC LITERATURE REVIEW

	<u>Author, date</u>	<u>Study population</u> Number Ages at data collection Sampling information (if applicable)	<u>Measure of regulation</u> Type / **term used** / measures / *predictor, moderator* ***or*** *outcome*	<u>Measure of parenting aspect</u> **(**if applicable)	**<u>Outcome</u>** / measure	<u>Confounders / controls / comments</u>	<u>Results</u>
1	Fitzpatrick & Pagani, 2013	N = 960 6 yrs – 10 yrs	Behavioural & cognitive / **classroom engagement** / newly developed scale / *predictor*	NA	**Academic, teacher-child conflict, peer problems, inattention** – social behaviour q'naire teacher report		Higher classroom engagement (regulation) predictive of better academic outcomes, less teach-child conflict, less inattention and fewer peer problems.
2	Troxel et al., 2013	N = 776 dyads 24 – 36 – 54 months	Biobehavioural & emotional / **sleep problems** & **negative emotionality**/ neg emot – in home observation of dyad play, sleep probs – CBCL /sleep problems as *mediator* between attachment security and later int and ext behaviour problems. Negative emotionality as a *moderator* of this effect.	NA	**Int and ext behaviour problems /** CBCL teacher report	Attachment security – in-home observation, maternal depression and socio-economics	Sleep problems at three years mediated relationship between attachment security at 2 years and behaviour problems at 5 years. This was particularly so for those infants high in negative emotionality (moderator effect).
3	Perry et al., 2013	N = 226 3 – 4 – 5 years	Emotional / **physiological regulation** / RSA during frustration tasks / *outcome*	**Maternal emotional support** – CCNES survey and observations during dyadic play	**Physiological regulation**		Physiological reactivity stable from 3 to 5 years, but improvements in physiological regulation. Maternal emotional support predictive of trajectory

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							of regulation, but not initial reactivity.
4	Barnes et al., 2013	N = 1000 9mths – 2 yrs – 4 yrs – 5 yrs Twins	All / **self-regulation** / Infant/Toddler Symptom Checklist / *predictor*	**Spanking** – parent report	**Externalising behaviour problems /** Preschool and Kindergarten Behaviour Scales	Race and gender	Lower self-regulation at 2 years lead to more spanking and more ext probs at 4 years which lead to higher externalising problems at 5 years. Much of this accounted for by shared genetics (twin study)
5	Blair et al., 2013	N = 336 5 yrs – 7 yrs – 10 yrs	Emotional / **emotion regulation** / Emotion Regulation Checklist / *mediator*	**Maternal emotion socialisation** – Coping with Children's Negative Emotions Scale (CCNES)	**Friendship quality** / Friendship Quality Questionnaire	Gender, maternal education	Maternal emotion socialisation at 5 years did not directly predict children's friendship quality at 10 years, but did so through effect on emotional regulation at 7 years. No gender effects.
6	Ostrov et al., 2013	N = 96 42 mths – 46 mths	Emotional / **emotion regulation** / Emotion Regulation Checklist-teacher / *predictor* & *outcome*	NA	**Peer rejection /** Preschool Social Behaviour Scale - teacher	Aggression and forms of – proactive or reactive / classroom observations.	Proactive relational aggression predicted positive change in ER, reactive relational aggression predicted negative change. ER did not predict change in aggression as predicted, but rather anger did.
7	Bolten et al., 2012	N = 120 29 week gestation – 6 weeks	Behavioural and emotional / **crying & fussing** / diary / *outcome*	**Prenatal stress and self-efficacy** – DASS & Competence and Control Q	**Infant crying & fussing /** diary	Maternal age, alcohol, parity, smoking, birth weight, gestation age, mode of delivery, gender - moderators	Prenatal stress and self-efficacy predicted crying and fussing. Self-efficacy moderated this relationships and provided a buffer against prenatal stress.

	Author, date	Study population Number Ages at data collection Sampling information (if applicable)	Measure of regulation Type / **term used** / measures / *predictor, moderator* ***or*** *outcome*	Measure of parenting aspect **(**if applicable)	**Outcome** / measure	Confounders / controls / comments	Results
8	Nelson et al., 2012	N = 260 3yrs – 4yrs	Emotional / **emotion regulation** / ERC and cardiac/ *outcome*	**Maternal emotional expressiveness –** clusters based on self-report		Children's emotion knowledge and expression	High positive and low negative emotion mothering style was the most supportive of children's emotional regulation
9	Dollar & Stifter, 2012	N = 90 4.5 yrs – 6 yrs	Emotional / **emotion regulation** / LABTAB – coded for types of ER strategies / *moderator*	NA	**Social behaviours and peer relationships**	Temperament as predictor – Observed Child Temperament Scale	High surgency children had more negative peer interactions but this was moderated by social support seeking (positively) and distraction / self-soothing (negatively) ER strategies
10	Razza et al., 2012	N = 316 4 mths – 2 yrs – 5 yrs	Emotional / **delay of gratification** / lab task / *outcome*	**Warmth -** observation	**Regulation during delay of gratification, int and ext problems on CBC**	Infant anger – IBQ as predictor, socio-economic, age and gender controls	Anger predicted behaviour problems but also interactive effects with maternal warmth in relation to regulation. That is, high infant anger made children more susceptible to the positive benefits of warm mothering in relation to regulation.
11	Bassett et al., 2012	N = 313 2 cohorts: 3 – 3.4 yrs – 4.4 yrs 4 – 4.4 yrs – 5.4 yrs	Cognitive and behavioural / **hot and cold EC** / Preschool Self-Regulation Assessment / *predictor*	NA	**Approaches to learning –** Preschool Learning Behaviour Scale, **Social Competence –** Social competence and behaviour evaluation, **Academic success**		Higher SE risk and being a boy associated with poorer EC. Time 1 cold EC predicted competence motivation and attention/persistence. Hot EC predicted attention, attitudes toward learning, anger/aggression and sensitivity / cooperation. Also associated with increases in these areas.

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12	Beiderman et al, 2012	N = 381 6-18 yrs at baseline then 4 yr follow-up a) Controls (no ADHD) b) ADHD group c) ADHD plus DESR	Emotional / **deficient emotional SR (DESR)** / CBCL / *moderator*	NA	**Psychiatric diagnosis**	ADHD diagnosis – predictor	ADHD groups higher rates of diagnoses of psych problems than control. ADHD plus DESR higher rates of comorbidity, social problems, global functioning and family environ. DESR lead to more persistent ADHD.
13	Slutske et al., 2012	N = 1023 3 yrs – 21yrs – 32 yrs	All **/ undercontrolled temperament** / 90 min observation / *predictor*	NA	**Disordered gambling-** interview and DSM	IQ, SES.	Undercontrolled group were about 10% of population and more likely to develop disordered gambling as an adult
14	Wang et al., 2012	N = 304 pairs of twins 6yrs – 7yrs – 8yrs 131 pairs MZ and 173 pairs DZ	Cognitive / **attention regulation** / CBC – teacher report and Bayleys Behaviour Record obs / *predictor*	NA	**Externalising beh -** CBC	Household chaos	Attention predicted ext beh probs. Relationship stronger when household chaotic.
15	Spinrad et al., 2012	N = 232) 30mths – 42mths – 54mths	Cognitive and behavioural **/ Effortful control** / ECBQ and CBQ and delay task / *predictor, outcome, mediator*	**Maternal sensitivity and warmth** – observed during task	**Committed compliance –** observed and ITSEA	Impulsivity - ITSEA	Maternal warmth and sensitivity at 30 mths predicted EC a year later and EC predicted compliance. Compliance also predicted EC a year later.
16	Zentall et al., 2012	N = 46 7mths – 12mths – 14mths	Biobehavioural / **sleep regulation** /parent report of night waking /	**NA**	**Attachment –** Strange Situation		No differences among attachment groups in sleep regulation at 7mths, however, by 12 months, securely attached infants had less night waking.
17	Honomichl &	N = 990	All / **Negative**	**NA**	**Ext probs –** CBCL	SES, gender	EC predicted adolescent self-

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	Donnellan, 2012	54mths – 15yrs	**affectivity** and **Effortful control** / CBQ / *predictor*		and self-report, **adjustment, risk-taking, future outlook.**		regulation, risk taking and mother-report ext probs. Neg affect predicted mother-reported ext probs. EC related to future planning at low levels of negative affect, but not in high (moderator effect). Relationship of EC to ext behs and risk taking mediated by impulse control and future planning.
18	Choe, 2012	Study1: N = 251 7mths – 15mths – 33mths Study 2:N = 224 3 yrs – 6 yrs – 10yrs	Cry, feed, sleep / **functional self-regulation /** Crying Patterns Q'naire, Sleep Habits Scale/ *moderator* All / **effortful control** / mother report on CBQ / *moderator*	**Maternal depression** **Maternal depression**	**Externalising beh probs –** ITSEA at 15 and 33 mths and CPCL at 33 mths. **Ext probs –** teacher and mother report	SES, gender	Maternal depression contributed to more ext probs in children. Cross-lagged effect more pronounced for boys. Child-driven effects found only for well-regulated infants, not for poorly regulated infants. Ext probs and maternal depression relatively stable across this time period. Mother driven effects found for boys only and child-driven effects found for well-regulated children only.
19	Roben, 2012	N = 361 9 mths – 18 mths – 27 mths	Emotional **/ toddler anger expression** / lab task / *outcome*	**Depressive symptoms of adoptive mothers and fathers, preeclampsia, parent-child interaction**	**Toddler anger**		Mothers depressive symptoms related to toddler anger. Father symptoms related only to mother symptoms, not directly to toddler anger. Parent-child interactions had a moderating effect such that anger

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							expression was influenced by genetic (pre eclampsia) and environmental (parental depression) risks only when negative interactions present.
20	Fan, 2011	N = 235 3yrs – 6yrs – 10yrs	Emotional / **emotion dysregulation** / lab and mother-report on temperament and teacher report on dysregulation / *predictor*	**Negative parenting** – self-report	**Int problems –** mother and parent report		Emotion overregulation and negative parenting predicted int problems.
21	Graziano et al., 2011	N = 447 2yrs – 4.5yrs	Emotional and cognitive / **negative reactivity and regulation strategies, sustained attention** / lab frustration and attention tasks / *predictors*	**Warmth, sensitivity, intrusive –** lab interactions			Help-seeking ER strategies associated with more sustained attention, while avoidance and highly controlling mothering associated with lower attention. Warmth predicted greater growth in attention across time and also acted as a moderator.
22	White et al., 2011	N=156 2 yrs – 4 yrs – 5 yrs	Behavioural and cognitive/ **inhibitory control; attention shifting /** lab – Stroop & dimensional change card sort /*moderator* between behavioural inhibition and anxiety problems	NA	**Social & emotional functioning** / CBQ (anxiety problems subscale as focus)	Behavioural inhibition (low sociability or approach) as observed in lab as predictor.	Attention shifting moderated effect (protective) of behavioural inhibition on anxiety problems. Higher levels of inhibitory control was a risk factor for anxiety problems when behavioural inhibition present.
23	Olson et al., 2011	N=199 3 yrs – 5.5-6 yrs	All /**effortful control** / lab – behavioural battery and maternal rating on CBQ (composite score of EC developed) /	**Warmth and harsh discipline** (self-report)	**Peer aggression** / preschool / kinder observations & teacher ratings	Negative emotional reactivity – lab and mother report. Theory of mind – lab.	Lower effortful control predicted children's concurrent and later peer aggression. Measures of effortful control and theory of mind were

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			predictor				positively intercorrelated. Poor effortful control associated with low parental warmth and harsh discipline.
24	Kim & Deater-Deckard, 2011	N=1079 4.5 years – 7 yrs – 9 yrs – 11 yrs	Cognitive/ **inattention** / mother, father and teacher report on various measures / *moderator* between dispositional anger and externalising - internalising problems	NA	**Internalising and externalising** /mother report on CBCL	Anger – multiple survey measures from parents and teachers - predictor	Children with lower attentional control showed higher levels of ext and int problems from 4.5 to 11. Attention moderated link between anger and externalising problems, but not internalising. The magnitude of the anger-inattention connection increased from 4.5 to 11 years.
25	Gagne & Goldsmith, 2011	n= 735 - 1021 12mths – 36 mths MZ and DZ twins	Behavioural & emotional/ **Inhibitory control** / lab and parent report (IBQ and CBQ) / predictor	**na**	**Anger** – lab and parent report	na	Lower levels of inhibitory control related to higher levels of anger. Boys had higher levels of anger and lower inhibitory control than girls.
26	Bridgett et al., 2011	N=158 4mths – 6mths – 9mths – 12mths – 18mths	All/ **Orienting-Regulation and Effortful control** / mother report – IBQ and ECBQ/ Infant orienting-regulation as *predictor* of effortful control (outcome)	**Maternal effortful control** – self-report; **Time spent in caregiving activities** – self-report	**Effortful control** at 18mths	Infant negative emotionality – parent report	Toddler effortful control predicted by slope and intercept of infant orienting – regulation, maternal effortful control and maternal time spent in caregiving. Maternal effortful control predicted time mothers spent in caregiving.
27	Schmid et al., 2010	N= 4427 Newborn – 5mths – 20mths – 56 mths Hospitalised' at risk'	BioBehavioural? / **regulatory problems** incl crying, feeding, sleeping / parent interview & paediatrician	**na**	**Adaptive behaviour and social skills** at 56 mths (parent report)		Prevalence of regulatory problems in this population provided incl over half had at least one regulatory problem at some time during the

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		(caesarean, premature, birth or neonatal complications)	assessment / *predictor*				measurement period. For 7 – 8% of these children problems were highly persistent from infancy to preschool. Girls had less regulatory problems. Associations between prior regulatory problems and future social and adaptive problems provided.
28	Ramani, et al., 2010	N=435 36mths – 54mths	Behavioural & emotional/ **Regulation & Dysregulation** / lab, childcare observed and mother report compliance (regulation) and defiance (dysregulation), lab resistance to temptation and delay of gratification / *predictor*	**na**	**Positive and negative behaviour with peers** (maternal report on Adaptive Social Behaviour Inventory and Social Skills Rating System, childcare observations and dyadic play with friend in lab)	Maternal education and income	Concurrent associations between higher regulation and positive peer interactions – with these links stronger and more consistent at preschool age. Similar associations longitudinally though earlier dysregulation did not predict later negative peer interactions as anticipated. Impulse control had the strongest effect.
29	Morris et al., 2010	N=40 5yrs – 7yrs	Emotional / **anger regulation** / Lab task – expressed anger and emotional regulation strategy attempts (moderator – see notes column 6) / *predictor*	**na**	**Externalising problems** (teacher report)	Attention refocusing as emotional regulation strategy – moderator between anger regulation and externalising problems.	Observed anger dysregulation associated with concurrent and later externalising behaviour. Children high in anger displayed less externalising behaviours when they used attention refocusing strategies. Attention refocusing associated with lower anger levels.
30	Graziano et al., 2010	N=435 2 yrs – 5.5. yrs	All / **emotional regulation, reactive**	**Maternal behaviour - sensitivity, warmth and**	**reactive control & effortful control**	Gender, race, maternal education and socio-	No gender differences in effortful control (EC); Higher

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			control, effortful control / Lab tests for emotional regulation and effortful control, parent report for reactive control (ADHD rating scale) / emotional regulation *predictor*, reactive control & effortful control outcomes	**control** in lab test		economic status	levels of EC linked with higher maternal education and higher socio-economic status. High maternal control at age 2 negatively predicted EC at age 5.5 and was marginally related to lower levels of reactive control growth. High maternal warmth at age 2 positively predicted children's EC at age 5.5.; Better emotion regulation skills linked with higher levels of reactive control at age 2 but not with increased rates of growth over time. Emotion regulation skills at age 2did not predict EC abilities at age 5.5 as anticipated.
31	Eisenberg et al., 2010	N = 209 – 255 (179) 18mth – 3- mths – 42 mths	Cognitive & behavioural / **effortful control** (EC) / lab delay task and general lab observation; mother and carer report on ECBQ& CBQ/ *predictor and outcome*	**Maternal teaching strategies** incl cognitive, directive and questioning strategies (challenging teaching task with child in lab)	**Effortful control and maternal teaching strategies**	Child vocabulary (mother report); Socio-economic status (mother report); age; gender	EC predicted maternal teaching strategies across time (child-driven effects), not vice versa; maternal cognitive assistance associated concurrently with EC at 18mths and 42 mths. Higher EC at each time point predicted higher use of maternal cognitive assistance at next time point. EC at each time point predicted lower maternal directives one year later. Results for maternal questioning also provided.

	Author, date	Study population Number Ages at data collection Sampling information (if applicable)	Measure of regulation Type / **term used** / measures / *predictor, moderator* ***or*** *outcome*	Measure of parenting aspect **(**if applicable)	**Outcome** / measure	Confounders / controls / comments	Results
32	Brown, 2010	N=196 3.5yrs – 4.5yrs	Emotional / **emotional regulation** / Emotional Regulation Checklist (mother report) and lab frustration task / *outcome*	**Maternal emotional socialisation** *(*self-report: *Coping with Children's Negative Emotions) - predictor*	**Emotional regulation**	Vagal regulation – mediator between maternal emotional socialisation and children' emotional regulation abilities	None of the four hypotheses were supported: Supportive / non-supportive maternal emotional support at age 3.5 did not predict children's emotional regulation at age 4.5, also parenting did not predict vagal suppression, higher vagal suppression did not lead to more adaptive emotional regulation as expected. No mediating role found for vagal suppression.
33	Blandon, Calkins & Keane, 2010	N=253 Oversampled to include higher risk for externalising behaviours 2yrs – 5yrs	Emotional / **emotional regulation** / lab frustration task and mother report on Emotion Regulation Checklist / *predictor* (termed toddler risk when added with toddler externalising behaviour)	**Parenting behaviour**(lab test: adult vs child orientated verbalised goals and warmth, sensitivity and strictness)	**Perceived peer acceptance** (self report at 5 years) **social skills and problem behaviours** (teacher report at 5 yrs); **Social preference** and **aggression** (peer report)	**Externalising behaviour** (mother report on CBCL at 2 yrs) – predictor when added with toddler emotional regulation (termed 'toddler risk').	Higher toddler risk (low emotion regulation and high externalising behaviours) associated with lower emotion regulation and social skills, more problem behaviours, land lower rating of likeability by peers at age 5. Higher toddler risk also related to higher self-rated peer acceptance by children. Under conditions of high toddler risk, higher maternal control associated with higher levels of negativity and lower emotional regulation.
34	Blandon, Calkins, Grimm et al., 2010	N= 440 Oversampled to include higher risk for externalising	Emotional / **emotion regulation** / Emotion Regulation Checklist (mother and teacher	**na**	**Social skills** (teacher report on SSRS) **Externalising**		The continuity model suggested stability in all of the behaviours assessed (externalizing behaviour, emotion regulation,

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		behaviours 2yrs – 4yrs – 5yrs – 7yrs	report) / *predictor* and item in longitudinal cascade model		**behaviour** (mother report on CBCL and teacher report on Behaviour Assessment System for children; **Peer acceptance (peer report)** (all items in longitudinal cascade model)		social skills, and peer acceptance) across age range. Cascade model indicated that emotional regulation and social skills were not stable across the period. Children's ability to regulate their emotions influenced their later levels of externalizing behaviour.
35	Bernier et al., 2010	N= 80 13mths – 15mths – 18mths – 26mths	Cognitive & behavioural/ **Executive functioning (EF)**/ in home tests – including new development of 18mth test / *outcome*	**Maternal sensitivity** (in home observation), **mind-mindedness** (use of mental terms with child – in home play session observed) and **autonomy support** (in home challenging play task)	**Executive functioning**	**Cognitive ability (**MDI – Bayley**)**	Overall early quality parenting predicted later EF with some differential effects for type of parenting behaviour and measure of EF. Some relationships also did not hold after controlling for child cognitive ability. Autonomy support was the parenting aspect that most robustly related to age-specific indices of child EF.
36	Sanson et al., 2009	N=2443 4-8mths – 1-2yrs – 2-3yrs – 3-4yrs – 7-8yrs – 11-12yrs	Cognitive**/ attention regulation** /parent report on RITQ and CTQ (persistence and distractibility scales) / *predictor*		**Behaviour problems** (parent and teacher report on CBQ at ages 7-8 and 11-12 and child self-report at 11-12yrs) **Social skills** (teacher report at 7-	**Socio-economic status** (parent report on occupation level and education when children 4-8mths)	Four clusters identified with one marked by (and named) *high attention regulation* and another *poor attention regulation.* More males in the poor attention regulation group. Those in poor attention cluster tended to have more behaviour problems and poorer social skills. By teacher report, these

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					8 yrs, teacher, child and parent report on SSRS at 11-12 yrs) **School functioning – academic** (teacher reported and child test)		were also more aggressive and hyperactive at ages 7 through to 12, with higher ext behs. By parent report, also at greater risk of internalising problems. Teacher reported behaviour problems lowest for those in the high attention regulation group.
37	Kochanska et al., 2009	N=99-102 7mths - 15mth – 25mths – 38mths – 52mths	Cognitive & behavioural / **effortful control** (EC) / lab tests / *outcome*	**Attachment security** (strange situation at 15mths) - moderator	**Effortful control**	**genotyping -** predictor	Sig gene-environment interaction. Children's genotypes: 5-HTTLPR polymorphism (having a short allele, ss or sl) associated with a diminished SR capacity from age 2 to 4½ but only for children who were insecurely attached to their mother at the end of the first year.
38	Pesonen et al., 2008	n=231 6mth – 5.5yrs	Emotional and cognitive (temperamental) / **Duration of orienting, soothability and distress to limitations** in infancy and **effortful control** at age 5 / IBQ and CBQ / *predictor and outcome*	**Maternal stress** (self-report) – predictor and outcome			Maternal stress in infancy lead to a decrease in attentional focussing, soothability and negative affectivity in childhood. Only one significant child driven effect from infant activity level to decreased maternal stress in childhood.
39	Jennings et al., 2008	N= 100 20mths – 27mths – 34mths	Behavioural and cognitive / **self-regulation** / tasks from Kochanska / *outcome*	**Maternal warmth** (observed during task) and **depression** (clinical interview) - moderators	**Self-regulation**	Moderators: **Understanding of self-as-object and understanding of**	Maternal depression played no role in development of self-regulation and did not show expected association with maternal warmth.

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						agency (tasks at 20mths and 27mths) Controls: **Difficult temperament** (child Characteristics Q'naire) **SES, gender, Cognitive ability** (Bayley MDI)	Understanding of self-as-object and of agency, and maternal warmth promoted development of better self-regulation skills, even when cognitive development, SES, difficult temperament and gender controlled for. Maternal warmth more important for development of self-regulation when toddlers have less understanding of agency. Measures at 20mths of age predicted self-regulation outcome at 34mths of age, better than the same measures at 27mths.
40	Jahromi & Stifter, 2008	N=86 4.5yrs – 5.5yrs	All / **emotional expression and regulation, behaviour regulation, executive function** (cognitive regulation) / lab tests / *predictors and outcomes*		**Theory of mind** (lab tasks re false belief)	Verbal ability (PPVT)	Competence in each of the three regulation domains were related to performance in other domains. Lower emotional regulation predicted poorer behavioural and cognitive regulation. Behavioural and cognitive regulation also related as expected. Executive function at 4.5 yrs related to higher scores on false belief task, but the same relationship was not found for emotional and behavioural regulation.
41	Higgins, 2008	N=100	Emotional / **emotional regulation** / observed	**Parenting style** (harsh, permissive, developmentally	**Emotional regulation**		Secure attachment or parenting style did not predict emotion

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		12mths – 15mths – 24mths	during teaching lab test with researcher / *outcome*	appropriate) - lab play, clean up and teaching tasks / predictor **Attachment** – Strange Situation - predictor			regulation.
42	Degnan et al., 2008	n=447 2 yrs – 4yrs – 5yrs	Emotional / **physiological emotional regulation** at 2 yrs / RSA / *predictor*	**Maternal controlling behaviour** (adult-oriented goals and strictness) – lab at 2 yrs - predictor	**Behaviour problems (**CBCL mother report) at 2, 4 and 5 yrs	SES, race, gender and frustration reactivity at 2yrs (lab test) - predictors	No gender or race effects. Family SES at 2 yrs negatively related to disruptive behaviour at 2 yrs. Four behaviour profiles identified: high, moderate, normative (moderate at age 2 and lower at age 4 and 5) and low. Children with high reactivity plus high control mother were more likely to be in the high behaviour, as were children with low physiological regulation and low maternal control When children high in reactivity, physiological regulation was a protective factor leading them to be more likely to be in the normative, rather than high groups. No effects for group membership based on maternal control alone. Combination of low reactivity and high regulation lead to children being in the low group.
43	Crockenberg et al., 2008	N=64 6mths – 2.5yrs	Cognitive and emotional / **attention shifting** from	**Maternal behaviour** (during lab frustration task)	**Aggression** (mother report on CBCL) at		Infant attention to frustrating event predicted aggressive behaviour 2 yrs later. Attention

	Author, date	Study population Number Ages at data collection Sampling information (if applicable)	Measure of regulation Type / **term used** / measures / *predictor, moderator **or** outcome*	Measure of parenting aspect **(**if applicable)	**Outcome** / measure	Confounders / controls / comments	Results
			and **distress** to frustrating event / mother report on IBQ a and lab frustration test at 6mths/ *predictors*	- moderator, **maternal trait anger** (self-report)	2.5 yrs		shifting away from frustrating event predicted lower aggression but only for girls. Infant distress to frustrating event predicted aggression only if mothers encouraged their infants to look at the event.
44	Calkins et al., 2008	N=447 2yrs – 5yrs Oversampled for externalising problems	Emotional and behavioural / **physiological regulation** / RSA, RSA change, HP, HP change across lab tests age 2 and 5yrs/ *outcome*	**Mother-child relationship quality** variable, - predictor - composite of: ....**Maternal behaviour** at 2 yrs (positive behaviour and hostility composites) – lab task +**....Maternal stress** at 2 yrs (self-report on PSI)	**Physiological regulation**	SES, gender, race, maternal education Behaviour problems at 2 and 5 yrs (mother report on CBCL) - predictor	Higher parent-child relationship quality related to higher SES and maternal education. Higher levels of relationship dysfunction between mother and child associated with lower levels of physiological regulation to challenge in children. These relationships held even when accounting for prior physiological regulation and early and concurrent behaviour problems. however unable to determine whether child or parent driven effects Early physiological regulatory ability were a strong predictor of those skills 3 years later providing evidence of stability. Concurrent externalising problems related to lower physiological regulation. Children showed higher levels of physiological regulation when working on a task with

	Author, date	Study population Number Ages at data collection Sampling information (if applicable)	Measure of regulation Type / **term used** / measures / *predictor, moderator* ***or*** *outcome*	Measure of parenting aspect **(**if applicable)	**Outcome** / measure	Confounders / controls / comments	Results
							their mother, than when working independently, regardless of level of dysfunction in relationships.
45	Blandon et al., 2008	N=269 4yrs – 5yrs – 7yrs Over sampled for risk for externalising problems	Emotional/ **emotional regulation, negativity & physiological regulation** /parent report on Emotional Regulation Checklist incl negativity subscale at each of 3 time points & baseline and change RSA at 4 yrs/ emotional regulation trajectory as *outcome,* physiological regulation as *predictor and moderator*	**Maternal depressive symptomatology** - self-report at 4 yrs- predictor **Negative parenting** – incl warmth, sensitivity, strictness and hostility during lab test at 4 yrs- control	**Emotional regulation development or trajectory**	Physiological regulation - predictor and moderator Negative parenting - control	Emotional regulation increased and negativity decreased over time. Higher child baseline RSA in conjunction with higher maternal depression at age 4 predicted lower emotional regulation at age 7 – contrary to hypothesis. Few maternal depression symptoms predicted mothers reporting greater increased in children's emotional regulation skills over time, where as high maternal depression predicted children being relatively stable in emotional regulation skills. High RSA change (vagal regulation) predicted more rapid increases in emotion regulation skills over time.
46	Sylvester, 2007	N=740 54mths – 6-7 years	All / **emotional regulation** incl attentional control, behavioural inhibition / continuous performance and delay of gratification in lab, parent report on CBQ/ *predictor*		**Peer related social competence –** observed in classroom and teacher report on SSRS – outcome and mediator **Academic**	Peer related social competence as mediator between emotional regulation and academic success Classroom supports **–** **o**bservation - mediator	Emotional regulation at 54 months positively associated with first grade peer competence. Emotional regulation at age 5 related to academic achievement in first grade, but not mediated by peer related social competence as hypothesised.

	Author, date	Study population Number Ages at data collection Sampling information (if applicable)	Measure of regulation Type / **term used** / measures / *predictor, moderator* ***or*** *outcome*	Measure of parenting aspect **(**if applicable)	**Outcome** / measure	Confounders / controls / comments	Results
					performance – battery and teacher report		
47	Belsky et al., 2007	N=1364 54mths – 6 years – 8 yrs –9yrs - 10 yrs	Cognitive / **attentional control** / CPT (continuous performance test) in lab / *mediator*	**Maternal sensitivity** (including supportive presence, respect for autonomy and hostility) – observer coded during tasks 54mths to 10 yrs - predictor	**Externalising behaviour problems** – teacher report on CBQ and others (with items tapping attention removed so as no overlap between mediator and outcome constructs)	Attentional control – mediator between parenting and behaviour problems	Lower levels of maternal sensitivity predicted lower attentional control at the following time point. Poorer attentional control predicted more externalising problems at following time point. Attentional control at 6 years partially mediated effect of insensitive parenting at 54 months on externalising problems at 8 years, and effect of sensitivity at 6 years on problem behaviour at 10 years.
48	Spinrad et al., 2006	N= 214 6 yrs – 8 yrs Selected to be included in the sample after screening if moderately or clearly at risk for behaviour problems (CBCL), then matched with controls	Emotional regulation / **effortful control (persistence) & impulsivity (reactive control)** / teacher and parent report on CBQ and lab observed persistence to puzzle task / *predictors*		**Socially appropriate behaviour, popularity, personality resiliency & problem behaviour /** parent report on CBCL and teacher report on teacher report form	Gender, age and problem behaviour risk - moderators	EC predicted later resiliency and resiliency predicted adult-rated popularity even after controlling for previous levels of constructs. Pointing to possibility that resiliency mediates the relations of effortful control popularity over time. High impulsivity at time 1 predicted lower popularity 2 years later. High correlations between EC and social competence indicating that constructs may be redundant – so social competence was

	Author, date	Study population Number Ages at data collection Sampling information (if applicable)	Measure of regulation Type / **term used** / measures / *predictor, moderator* ***or*** *outcome*	Measure of parenting aspect **(**if applicable)	**Outcome** / measure	Confounders / controls / comments	Results
							dropped from further analysis.
49	Hill et al., 2006	N=383 2yrs – 4yrs – 5yrs Screened on mother report CBCL - externalising and placed into high / low risk groups	Emotional and cognitive / **emotional regulation and inattention** / lab task at for emotional regulation, parent report on ADHD Rating Scale for inattention, both at 2 years / *predictor*		**Externalising behaviour problems** – mother report on CBCL at each time point / outcome	SEMM, Latent profile analysis, , semi-parametric group based approach.	Children from lower SES had more behaviour problems at age 2, no race differences. Four profiles for behaviour problems found from 2 to 5 years: chronic-clinical, sub threshold (starting clinical but decreasing), normative (moderate at 2 years then decreasing), low – similar for both genders. Low SES at age 2 was a risk factor for boys but not girls (membership in clinical group).Emotional regulation at age 2 important predictor for girls membership between clinical and sub threshold groups, but not for boys. Inattention at age 2 was a risk factor for both girls and boys.
50	Colman et al., 2006	N=855 4.5 – 8.5 yrs	Self-regulation / **self-regulation** / mother report on the Behaviour Problems Index / *outcome*	**Maternal warmth – i**nterviewer report **Physical discipline –** mother self-report - predictors	**Self-regulation**	ANOVA, regression	Children with mothers who were more warm and used less physical punishment at age 4.5 were rated as higher in self-regulation skills 4 y ears later, even when earlier regulation skills controlled for. No gender or race differences in this relationship.

APPENDIX C B COHORT CHARACTERISTICS – LSAC AND ABS COMPARISON

(Australian Institute of Family Studies, 2009).

	Wave 1		Wave 2		Wave 3	
	LSAC %	**ABS %**	**LSAC %**	**ABS %**	**LSAC %**	**ABS %**
Gender[(a)]						
Male	51.2	51.4	51.1	51.4	51.3	51.4
Female	48.8	48.6	48.9	48.6	48.7	48.6
Family type						
Two resident parents/guardians:	90.7	88.3	89.0	85.1	88.9	82.5
- both biological	90.1	na	88.0	na	85.9	na
- step or blended family	0.2	na	0.8	na	2.9	na
- other	0.4	na	0.2	na	0.1	na
One resident parent/guardian:	9.3	11.7	11.0	14.9	11.1	17.5
- biological	9.3	na	10.9	na	11.0	na
- other	0.1	na	0.1	na	0.1	na
Siblings						
Only child	39.5	39.4	19.3	24.4	10.4	13.4
One sibling	36.8	35.5	49.1	45.5	48.1	47.9
Two or more siblings	23.7	25.1	31.6	30.0	41.5	38.7
Ethnicity						
Aboriginal or Torres Strait Islander	4.5	4.3	3.9	4.3	3.4	4.5
Parent 1 speaks a language other than English at home	14.5	18.0	13.4	18.5	12.6	18.2
Work status						
Both parents or lone parent work	47.9	nc	56.9	nc	63.0	nc
One parent works (in couple family)	40.8	nc	33.8	nc	29.7	nc
No parent works	11.3	nc	9.3	nc	7.4	nc
Educational Status						
Mother completed Year 12	66.9	nc	69.0	nc	69.8	nc
Father completed Year 12	58.5	nc	59.7	nc	60.4	nc
State[(a)]						
New South Wales	31.6	33.5	31.1	33.2	31.1	33.1
Victoria	24.5	24.5	24.3	24.7	24.6	24.3
Queensland	20.6	20.3	21.4	20.3	22.0	20.5
South Australia	6.8	6.8	6.7	7.1	7.0	7.1
Western Australia	10.4	9.8	10.6	9.8	10.3	9.8
Tasmania	2.2	2.3	2.3	2.3	2.4	2.4
Northern Territory	1.7	1.1	1.4	1.2	1.2	1.2
Australian Capital Territory	2.1	1.7	2.2	1.6	2.4	1.5
Region						
Capital City Statistical Division	62.5	64.9	61.9	64.4	61.8	62.8
Balance of State	37.5	35.0	38.1	35.6	38.2	37.2

na = not available; nc =comparable data not available.

APPENDIX D LSAC VARIABLE LABELS

Self-regulation variables

Wave	Measure	Located in	Scales - items	LSAC variable code
1	*Short Temperament Scale Infants* (STSI)	Leave behind questionnaire	Irritability – 4 items	ase01c1 to c4
	Biobehavioural regulation	Interview	Sleeping problems - 4 items	ahs201b3 to 6
			Feeding problems – 1 item	ahb11
2	*Short Temperament Scale Toddlers* (STST)	Leave behind questionnaire	Persistency – 5 items	bse01e5 – e9
			Reactivity – 4 items	bse01f5 – f8
	Biobehavioural regulation	Interview	Sleeping problems - 4 items	bhs20b3 to b5 and hs20b11
3	*ShortTemperament Scale Children* (STSC)	Complete during interview	Persistency – 4 items	cse01e1 to e4
			Reactivity / inflexibility – 4 items	cse01f1 to f4
	Biobehavioural regulation	Interview	Sleeping problems - 4 items	chs20b3 to b5 and b11

Parenting variables

Variable	Wave and location of item	Measures	Variable labels
Maternal mental health	Wave1: Leave behind questionnaire Wave 2, 3 and 4: complete during interview	Kessler K6 (6 items)	Wave 1: ahs24a1 – a6 Wave 2: bhs21a1- a6 Wave 3: chs24a1 – a6 Wave 3: dhs24a1 – a6
Parenting efficacy	Wave 3: complete during interview	4 items	cpa12a1 – a4
Warmth		6 items	cpa03a1 - 6a6
Hostility		4 items	cpa04a1 – a4
Anger		5 items	cpa13m2 – m6
Inductive reasoning		5 items	cpa09m1 – m5
Consistency		5 items	cpa11m2 - m7

APPENDIX E RESULTS OF CFA ANALYSIS FOR SECOND-ORDER FACTOR OF SELF-REGULATION (AN ALTERNATIVE EXPLORATION TO ANALYSES PRESENTED IN CHAPTER 4)

E.1 Approach to Analyses

Prior to conducting the analyses presented in Chapter 4, a different approach to modeling the relationships among the self-regulation constructs was explored. CFAs for the second-order latent variable of self-regulation (SR) were conducted using Mplus Version 7 software at each wave. All variables as described in the previous sections for cognitive, behavioural, and emotion regulation were treated in the analyses as ordinal categorical as a maximum of six-point response scales were used and so were not considered continuous. The estimator used was the WLSMV estimator, which provides “weighted least square parameter estimates using a diagonal weight matrix with standard errors and mean- and variance-adjusted chi-square test statistic that use a full weight matrix” (Muthén & Muthén, 1998 - 2012, p. 533). This estimator has been recommended where CFA analyses use data that are categorical or ordinal in nature (Brown, 2006).

At each wave, the variance of the second-order latent variable of SR was constrained to one in order to allow free estimation and examination of the contributions of each of the first-order latent variables. At each wave, the second-order part of the model was only “just identified” due to having only three indicator latent variables. In order to improve identification, the residual variances of the first-order latent variables were examined for similarity in baseline models and constrained to be equal where they were close in estimated value. This procedure provides an extra degree of freedom in the higher part of the model, improving model identification (Byrne, 2012).

E.2 Results

E.2.1 Wave 1: Infancy

In Wave 1, a first-order latent variable of reactivity regulation (REACT) was represented by the four reactivity temperament items (r1 – r4) and the first-order latent variable of sleep regulation (SLEEP) was indicated by four sleep items (s1 – s4). These first-order latent variables together with the eating regulation indicator[1] (e1) loaded on a second-order latent variable that was termed self-regulation (SR1). This initial model yielded poor fit indices as shown in Table E.1. It was noted that the residual variances of REACT (.199) and SLEEP (.168) were similar. These were therefore constrained to be equal in order to provide an extra degree of freedom in the upper part of the model to improve identification. However, inclusion of this constraint did not significantly impact on model fit, as indicated by the chi-square difference test statistic (x^2 = 1.034, *df* = 1, *p* = .309) and this constraint was not maintained in subsequent analyses.

Table E.1 *Fit indices for Wave 1 models.*

Model	**Chi-square (df)**	***p***	**RMSEA (90% confidence interval)**	**CFI**	**TLI**	**WRMR**
Recommended cut off values		*>.05*	*<.5*	*>.95*	*>.95*	*<1*
1A (baseline)	237.624 (25)	.000	.054 (.048 – .061)	.939	.912	1.730
1B (r2 with r4)	89.408 (24)	.000	.031 (.024 – .038)	.981	.972	1.052

The modification indices were then examined. It appeared that the error variances between items r2 (*amuses self for 30 minutes or more*) and r4 (*reverse of cries when left alone*) were not well replicated. This correlation was considered to make theoretical sense in that there could be some overlap in the measurement of these items. Children who are able to amuse themselves for 30 minutes or more are less likely to cry when left alone. The correlation of these error terms was freely estimated in the next model (Model 1B). Model 1B yielded improved fit indices, and

[1] *Feeding problems* were examined with the item at Wave 1 of LSAC only, “Are you having any problems with feeding this child at present?” Parents were asked to respond to one main issue as listed: breastfeeding; weaning; starting solids; other; no problems. For the purposes of this study, a dichotomous scoring system of one for no feeding problems (indicating a possible higher regulatory capacity in the infant) and zero for any feeding problems was used. A total of 284 children or 9.9% of the sample had parents who reported a feeding problem at Wave 1. This is referred to as eating problems or e1 in this Appendix.

examination of the DIFFTEST analysis used in Mplus to compare nested models yielded a non-significant chi-square (x^2 = 118.326, *df* = 1, *p* = .000), indicating that Model 1B was a significant improvement in fit to Model 1A.

In a further exploratory step, additional temperament items from the cooperation subscale of the LSAC version of the *Short Temperament Scale for Infants* (STSI-LSAC) were included in three different attempts to produce an improved fitting model. Firstly, a third first-order latent variable of COOPERATION, with four indicators from the STSI-LSAC, was added to the above models. Secondly, the eating problem indicator was removed, while the COOPERATION latent variable was maintained. Thirdly, the eating problem indicator was maintained, while the four COOPERATION items were included as part of the REACT latent variable. Finally, all indicators of interest were used in a first-order factor analysis with the only latent variable being SR1. None of these exploratory steps or re-specifications improved the model fit, nor the substantive interpretation of the model, and so were not pursued.

In examining the final model for Wave 1 (Model 1B), the exact test of model fit (that is, chi-square) is significant, meaning that the model would be rejected by the standard of this test. However, it has been noted by numerous leading authors, that the significance of chi-square is substantially impacted on by sample size and hence other fit indices must be examined (Goffin, 2007).When examining these other fit indices it was found that each was close to the commonly used benchmarks for fit for each index (< .05 for RMSEA, .95 for CFI, ..95 for TLI and <1 for WRMR; Byrne, 2012). Moreover, the 90% confidence interval for the RMSEA was narrow. Therefore this measurement model for broad self-regulatory capacity in the first year of life was accepted as having adequate fit.

The standardised parameter estimates for the final model (Model 1B) are shown in Table E.2 and also in Figure E.1. Figure E.1 also provides the r-squares for the second-order part of the measurement model which are shown in italics. The coefficients represent the results of probit regression analyses given the estimator chosen and the identification of all variables as categorical. All coefficients are significant and standard errors are small. The path coefficients and r-squares in the upper part of the model indicate that sleep regulation is the most reliable indicator of the broad self-regulation concept during infancy, closely followed by reactivity.

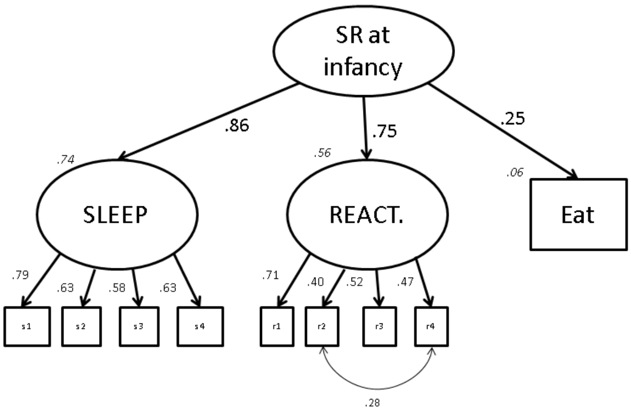


Figure E.1. Final measurement model for Wave 1 self-regulation with standardised estimates. R-square values are provided in italics. Fit statistics: x^2 = 89.408, *df* = 24, *p* = .000, CFI = .981, TLI = .972, RMSEA = .031, WRMR = 1.052.

Table E.2 *Wave 1 self-regulation model parameter estimates*

Parameter	**Unstandardised *(se)***	**Standardised *(se)***	***p***
Sleep1 → s1*	1 (.000)	.789 (.034)	.000
Sleep1 → s2	.797 (.059)	.629 (.037)	.000
Sleep1 → s3	.739 (.049)	.583 (.029)	.000
Sleep1 → s4	.796 (.057)	.628 (.035)	.000
React1 → r1	1 (.000)	.714 (.021)	.000
React1 → r2	.560 (.037)	.400 (.022)	.000
React1 → r3	.729 (.041)	.521 (.021)	.000
React1 → r4	.651 (.039)	.465 (.021)	.000
SR1 → e1	.253 (.044)	.253 (.044)	.000
SR1 → Sleep1	.679 (.092)	.861 (.122)	.000
SR1 → React1	.533 (.071)	.745 (.098)	.000
Covariance of r4 and r2	*.224 (.018)*	*.276 (.020)*	*.000*

* → represent regressions

E.2.2 Wave 2: Children aged 2-3 years

In Wave 2, three first-order latent variables of reactivity regulation (REACT indicated by four temperament items, r21 – r24) and attentional regulation (PERSIST indicated by five temperament items, p21 – p25) and sleep regulation (SLEEP indicated by four sleep items, s21 – s24) were created. These were then loaded on to the second-order latent variable of self-regulation (SR2) to create Model 2A. Following the initial estimate, the residual variances of the first-order latent variables were examined for similarity. They were not considered close enough in value to warrant constraining any to equal in order to improve model identification. Estimation of the initial model yielded poor fit indices as shown in Table E.4. The modification indices were examined and it appeared that item p24 (*stops to examine objects)* was not uni-dimensional, in that it appeared to have a correlated error term with many other items and also to cross-load on to the REACT latent variable. This item also had one of the highest rates of missing data among the temperament items for this sample, perhaps indicating that mothers found the item difficult to answer. Item p24 also had the lowest standardised regression estimate on the PERSIST factor. In the interests of parsimony it was decided to remove this item. This is the only instance in which five items rather than four items were used as indicators on a first-order latent variable. There were no items that were repeated across waves of data collection and so there was no need to maintain this item in the interest of repeated measures.

The resulting model (Model 2B) yielded improved fit indices. However, as the removal of an item meant that the models were not nested, chi-square difference testing through the Mplus DIFFTEST option was not available. In a further exploratory step, additional items from the dysregulation subscale of the *Brief Infant Toddler Social Emotional Assessment* (BITSEA; Briggs-Gowan, Carter, Irwin, Wachtel, & Cicchetti, 2004), also collected at Wave 2 were included as indicators of a fourth first-order latent variable. Due to the significant overlap in items between the BITSEA and the sleep and temperament items already included, a number of the BITSEA items became redundant. No significant improvements in model fit or interpretation were gained by exploring the addition of these items so this direction was not pursued any further.

In returning to Model 2B, as for the Wave 1 measurement model, the exact test of model fit failed (i.e., chi-square is significant). However, each of the other fit indices was close to the established thresholds and the 90% confidence interval for the RMSEA was narrow. Therefore this measurement model for broad self-regulatory behaviour at age 2 -3 years (Wave 2) was accepted as having adequate fit.

Table E.4 *Fit indices for Wave 2 models*

Model	**Chi-square (*df*)**	***p***	**RMSEA (C.I)**	**CFI**	**TLI**	**WRMR**
Recommended rules of thumb		*>.05*	*<.5*	*>.95*	*>.95*	*<1*
2A	376.213 (62)	.000	.042 (.038 – .046)	.971	.964	1.594
2B (remove p24)	191.107 (51)	.000	.031 (.026 – .036)	.986	.981	1.203

The standardised parameter estimates for the final model for Wave 2 (Model 2B) are shown in Table E.5 and also in Figure 4.2. R-squares for the second-order part of the model are also shown in Figure E.2 in italics. All estimates were significant, with relatively small standard errors. Estimates were generally lower than those for the Wave 1 model, with the r-square indices being particularly small. In examining the second-order latent construct of self-regulation, this factor accounted for the most variability in the sleep regulation latent variable, but accounted for very limited variability in the reactivity and persistence factors.

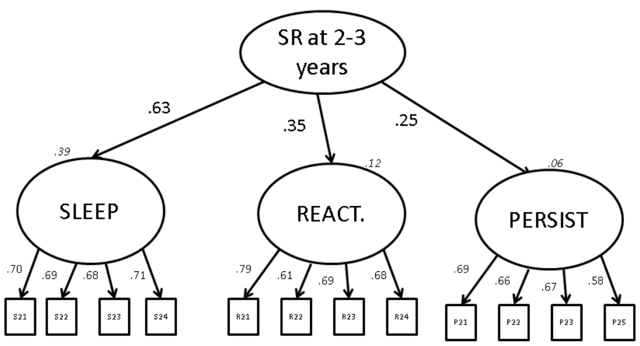


Figure E.2. Final measurement model for Wave 2 self-regulation with standardised estimates. R-square values are provided in italics. Fit statistics: x^2 = 191.107, *df* = 51, *p* = .000, CFI = .986, TLI = .981, RMSEA = .031, WRMR = 1.203.

Table E.5 *Wave 2 self-regulation model parameter estimates*

Parameter	Unstandardised *(se)*	Standardised *(se)*	*p*
Sleep2 → s21	1 (.000)	.695 (.032)	.000
Sleep2 → s22	.992 (.065)	.690 (.030)	.000
Sleep2 → s23	.973 (.064)	.677 (.029)	.000
Sleep2 → s24	1.018 (.069)	.708 (.036)	.000
React2 → r21	1 (.000)	.787 (.011)	.000
React2 → r22	.777 (.021)	.611 (.015)	.000
React2 → r23	.876 (.020)	.689 (.012)	.000
React2 → r24	.866 (.020)	.681 (.013)	.000
Persist2 → p21	1 (.000)	.688 (.015)	.000
Persist2 → p22	.962 (.031)	.662 (.016)	.000
Persist2→ p23	.967 (.029)	.665 (.015)	.000
Persist2 → p25	.846 (.030)	.582 (.016)	.000
SR2 → Sleep2	.435 (.076)	.626 (.106)	.000
SR2 → React2	.276 (.047)	.351 (.060)	.000
SR2 → Persist2	.170 (.032)	.248 (.046)	.000

E.2.3 Wave 3: Children aged 4-5 years

The Wave 3 measurement model had the same structure as Wave 2 with the exception that there was one less indicator for the PERSIST latent variable. Three first-order latent variables of emotion regulation (REACT indicated by four temperament items, r31 – r34), attentional regulation (PERSIST indicated by four temperament items, p31 – p34) and sleep regulation (SLEEP indicated by four sleep items, s31 – s34) were created. These were then loaded on to the second-order latent variable of self-regulation (SR3) to create Model 3A. Following the initial estimate, the residual variances of the first-order latent variables were examined for similarity, however they were not considered close enough in value to warrant constraining any to equal in order to improve model identification. This initial model yielded poor fit indices as shown in Table E.6.

The modification indices were examined and it appeared that the error terms of r32 (*difficult to sidetrack when angry*) and r34 (*difficult to comfort*) were showing significant measurement overlap. This correlation appeared to make theoretical sense because the wording of the items may have similar meanings for some respondents. Therefore, the error terms of these two items were allowed to correlate in the estimate of the next model (Model 3B). Model 3B yielded improved fit indices, and examination of the DIFFTEST analysis used in Mplus to compare nested models yielded a non-significant chi-square, indicating that Model 3B was a significant improvement in fit on Model 3A (x^2 = 219.005, *df* = 1, *p* = .000).

Although there were several other large modification indices indicating potential cross-loading of items, no further re-specifying of the model was conducted. This was to avoid the trap of being driven by the data and over-fitting the model using statistical estimates only, with no reference to substantive meaning. As for the Wave 1 and Wave 2 measurement models, although the exact test of model fit failed in the final model (that is, chi-square was significant), each of the other fit indices were close to the established thresholds and the 90% confidence interval for the RMSEA was narrow. Therefore this measurement model for broad self-regulatory at age 4-5 years (Wave 3) was accepted as having adequate fit.

Table E.6 *Fit indices for Wave 3 models*

Model	**Chi-square (*df*)**	***p***	**RMSEA (C.I)**	**CFI**	**TLI**	**WRMR**
Recommended rules of thumb		*>.05*	*<.5*	*>.95*	*>.95*	*<1*
3A	477.792 (51)	.000	.054 (.050- .058)	.971	.962	1.921
3B (r32 with r34)	243.194 (50)	.000	.037 (.032- .041)	.987	.983	1.358

The standardised parameter estimates for the final model for Wave 3 (Model 3B) are shown in Table E.7 and also in Figure E.3. The r-squares for the second-order part of the model are also shown in Figure E.3. All estimates were significant with small standard errors. In contrast to the Wave 1 and Wave 2 models, reactivity was the most reliable indicator of the second-order construct of self-regulation, with sleep regulation and persistence contributing moderately and approximately equally.

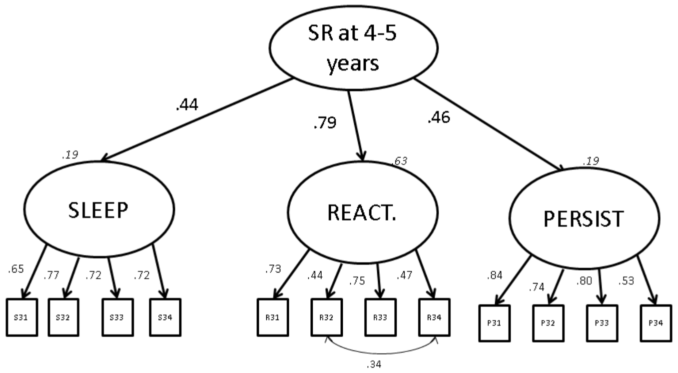


Figure E.3. Final measurement model for Wave 3 self-regulation with standardised estimates. R-square values are provided in italics. Fit statistics: x^2 = 243.194, *df* = 50, *p* = .000, CFI = .970, TLI = .983, RMSEA = .037, WRMR = 1.358.

Table E.7 *Wave 3 self-regulation model parameter estimates*

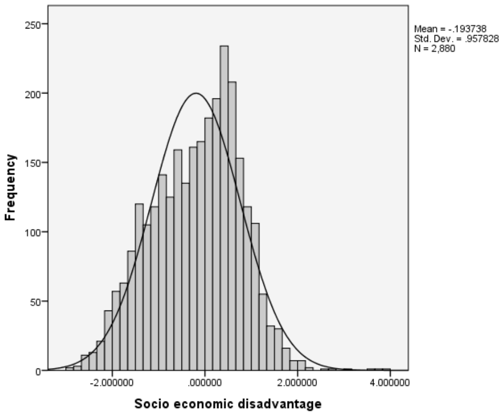
Parameter	**Unstandardised *(se)***	**Standardised *(se)***	***p***
Sleep3 → s31	1 (.000)	.650 (.035)	.000
Sleep3 → s32	1.181 (.082)	.767 (.031)	.000
Sleep3 → s33	1.106 (.076)	.718 (.032)	.000
Sleep3 → s34	1.100 (.083)	.715 (.041)	.000
React3 → r31	1 (.000)	.729 (.016)	.000
React3 → r32	0.604 (.029)	.440 (.019)	.000
React3 → r33	1.034 (.038)	.753 (.017)	.000
React3 → r34	0.645 (.030)	.470 (.020)	.000
Persist3 → p31	1 (.000)	.838 (.008)	.000
Persist3 → p32	.887 (.014)	.743 (.010)	.000
Persist3→ p33	.951 (.016)	.798 (.009)	.000
Persist3 → p34	.626 (.017)	.525 (.014)	.000
SR3 → Sleep3	.282 (.032)	.435 (.043)	.000
SR3 → React3	.578 (.050)	.792 (.067)	.000
SR3 → Persist3	.365 (.034)	.435 (.039)	.000
r32 with r34	.268 (.017	*.338 (.018)*	*.000*

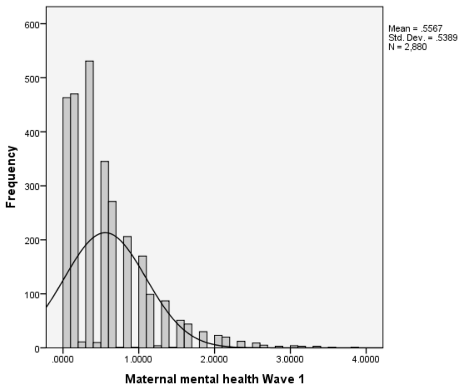
In order to explore the ways the measurement models formed over time, an overall model was estimated that included the three measurement models derived from Waves 1, 2, and 3. The second-order latent variable of self-regulation at each wave was allowed to correlate with the second-order latent variable at each other wave. As the only indicator variables which remained consistent over the three waves were those related to the sleep latent variable, both the latent variable of sleep and its four indicator variables at each wave were also allowed to correlate across time. Despite these correlations, the model was not able to be estimated due to a negative residual covariance for the latent variable of reactivity at Wave 1 and a correlation of over one between the latent variables of self-regulation at Wave 2 and Wave 3. These resulted in a non-positive covariance matrix which does not allow for the confident estimation of SEMs. This problem may indicate that the measurement models at each wave are measuring different concepts and cannot in any way be said to have measurement invariance. Two further options were pursued to examine the performance of the measurement models across time.

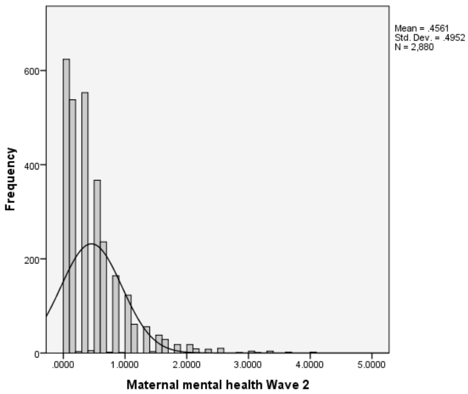
APPENDIX F ALTERNATE EXPLANATION FOR THE PREDICTION OF BETTER PERSISTENCE SCORES AT 2-3 YEARS FROM POORER SLEEP REGULATION DURING INFANCY.

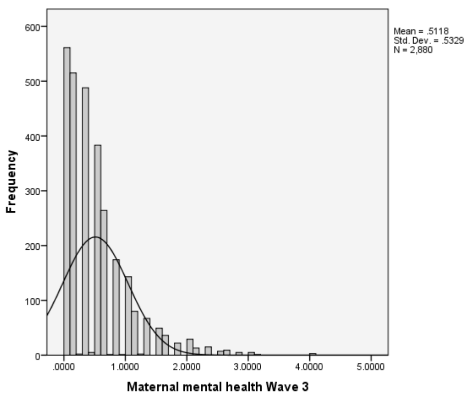
In the final longitudinal panel model presented in Chapter 4, the longitudinal relationships among sleep, emotion and cognitive regulation were examined. One unexpected finding emerged. Higher sleep regulation scores in infancy were associated with lower persistence scores at 2-3 years of age (β = -.222). This is a counter-intuitive finding that might represent a spurious statistical result. Alternatively, this finding might be explained in the context of the infant temperament typologies defined by Thomas and Chess (1977). In their work, nine dimensions of temperament were used to classify infants into three temperament typologies. The dimensions were rhythmicity (patterns of sleeping, eating and other physiological functions), mood, intensity, activity level, approach/withdrawal (to social and novel situations), adaptability, mood, threshold of responsiveness, intensity, distractibility and attention span / persistence (Thomas and Chess, 1977). Three temperament typologies were then defined in relation to these dimensions: ‘easy’, ‘difficult’ and ‘slow-to-warm-up’ (Thomas and Chess, 1977). In relation to rhythmicity (which includes sleep regulation), ‘easy’ infants were high in sleep regulation, ‘difficult’ infants were low, but ‘slow-to-warm-up’ infants varied. ‘Slow-to-warm-up’ infants also varied in their distractibility, but were low in adaptability and approach, low to moderate in activity and slightly negative in mood. In these ways, ‘slow-to-warm-up’ infants are said to represent a milder case of ‘difficult’ temperament (Grady, Karraker, & Metzger, 2012). The finding in this study of a negative relationship between sleep regulation in infancy and persistence two years later, might represent the influence of children within the sample who would be classified as ‘slow-to-warm-up’. As these infants tend to show variations in their sleep regulation, it may be that at the point of data collection during infancy, they were showing high levels of sleep regulation. They would also be characterised by lower levels of approach to new and novel situations, lower adaptability and higher inhibition (Kagan, Snidman, Kahn, & Towsley, 2007). It is therefore conceivable that ‘slow-to-warm-up’ infants would have less opportunity for cognitive development over the first three years due to their avoidance of novel situations. So, despite showing high sleep regulation at one measurement point during infancy, they might be rated as having poor persistence two years later. The presence of ‘slow-to-warm-up’ infants in the study sample may therefore have skewed the finding on this particular pathway in the model. While Grady et al. (2012) and Kagan et al. (2007) have investigated the developmental pathways of inhibitory and social behaviors of ‘slow-to-warm-up’ infants there are no studies investigating cognitive development associated with this temperament type. Further work should pursue this line of investigation.

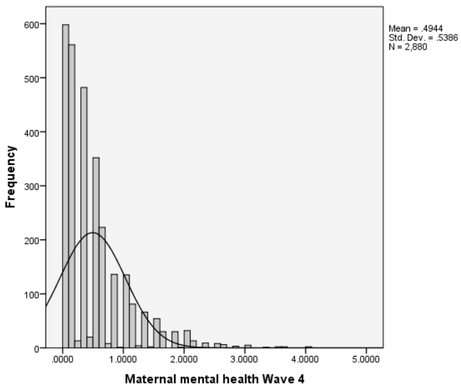
APPENDIX G HISTOGRAMS FOR CONTINUOUS VARIABLES USED IN THE THESIS

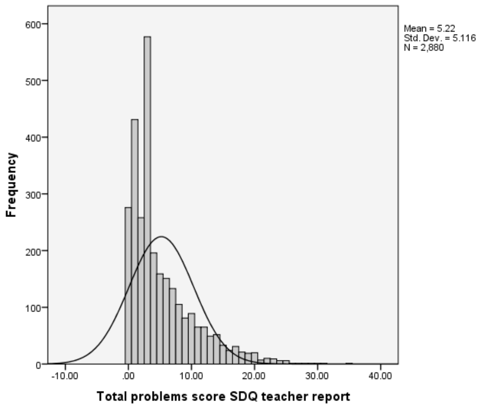


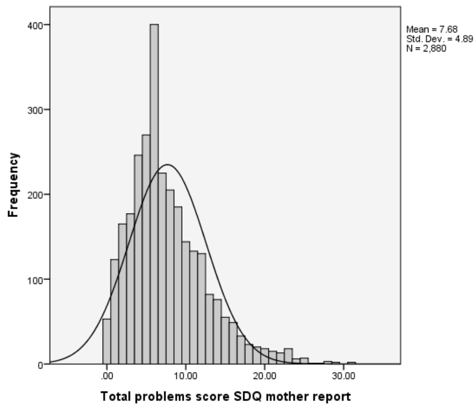


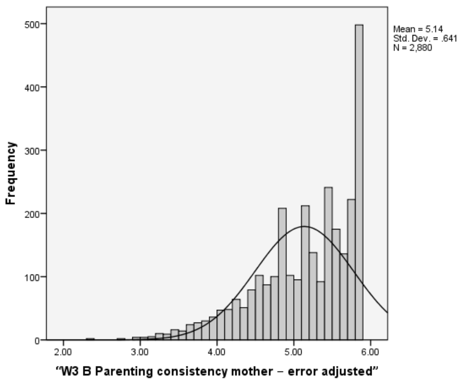


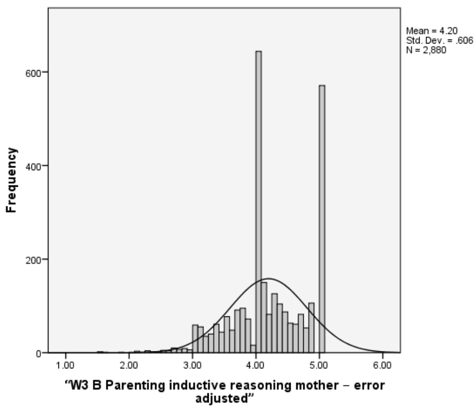


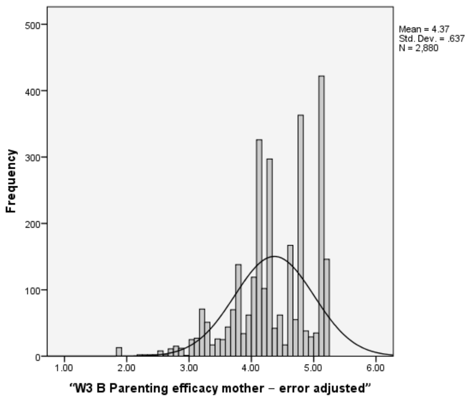


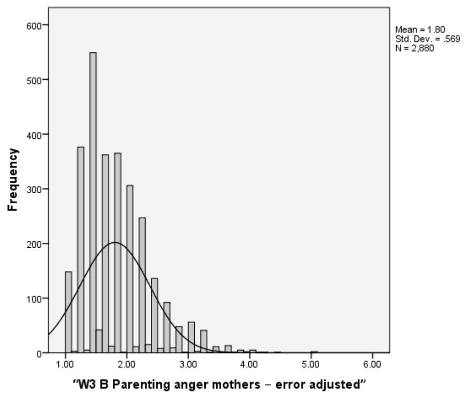

Mean = 5.22
Std. Dev. = 5.116
N = 2,880
Frequency
Total problems score SDQ teacher report

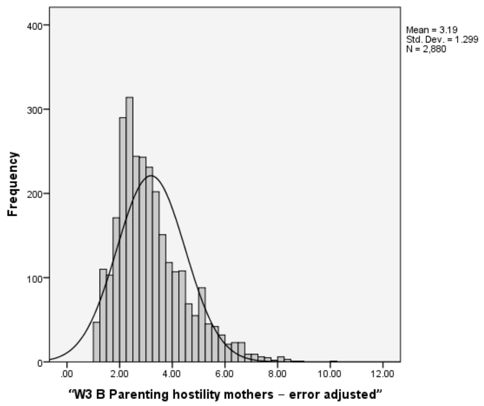

Mean = 7.68
Std. Dev. = 4.89
N = 2,880
Frequency
Total problems score SDQ mother report

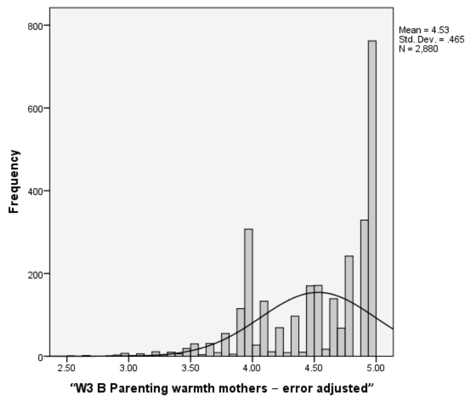

Mean = 5.14
Std. Dev. = .641
N = 2,880
Frequency
"W3 B Parenting consistency mother – error adjusted"

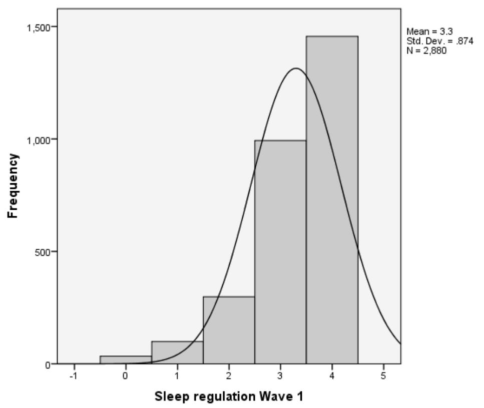

Mean = 4.20
Std. Dev. = .606
N = 2,880
Frequency
"W3 B Parenting inductive reasoning mother – error adjusted"

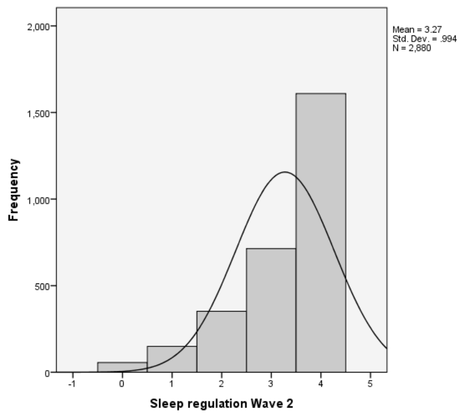

Mean = 4.37
Std. Dev. = .637
N = 2,880
Frequency
"W3 B Parenting efficacy mother – error adjusted"

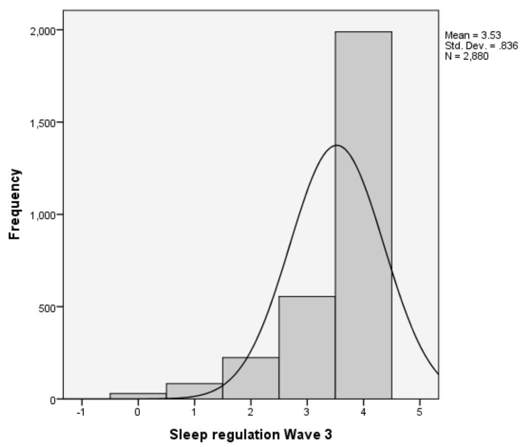

Mean = 1.80
Std. Dev. = .569
N = 2,880
Frequency
"W3 B Parenting anger mothers – error adjusted"

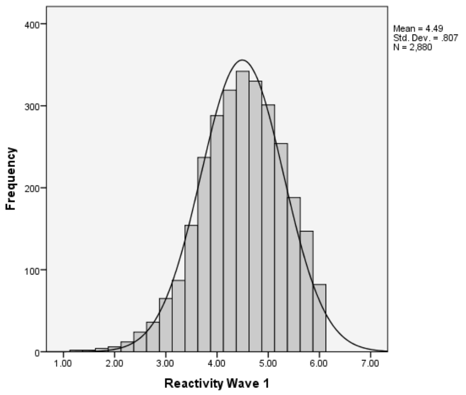

Mean = 3.19
Std. Dev. = 1.299
N = 2,880
Frequency
"W3 B Parenting hostility mothers – error adjusted"

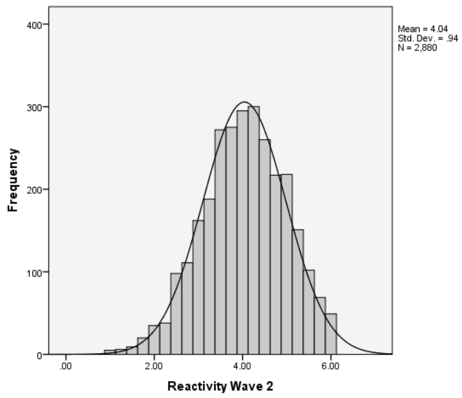

Mean = 4.53
Std. Dev. = .465
N = 2,880
Frequency
"W3 B Parenting warmth mothers – error adjusted"

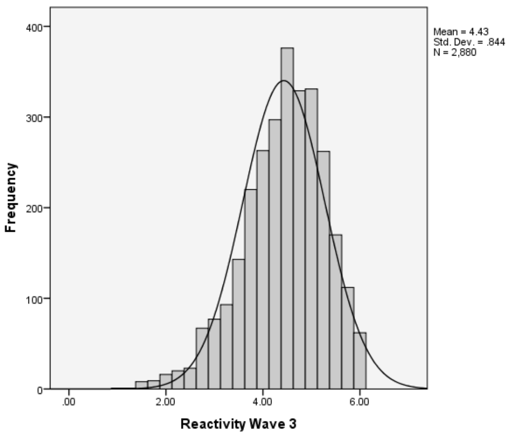

Mean = 3.3
Std. Dev. = .874
N = 2,880
Frequency
Sleep regulation Wave 1

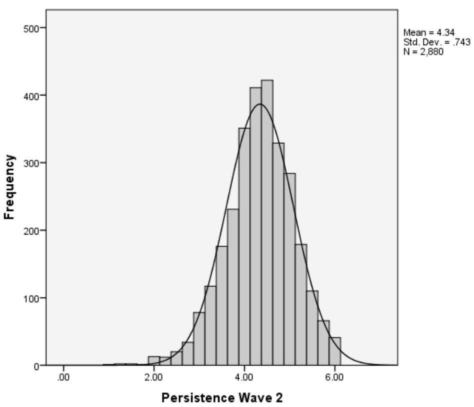

Mean = 3.27
Std. Dev. = .994
N = 2,880
Frequency
Sleep regulation Wave 2

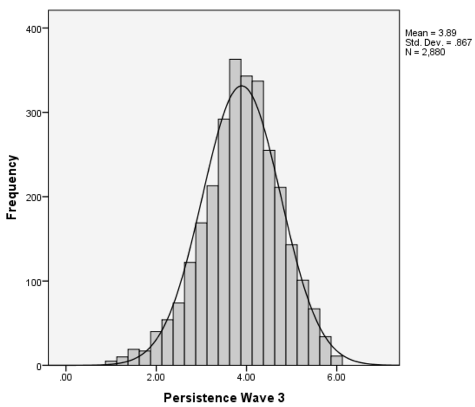

Mean = 3.53
Std. Dev. = .836
N = 2,880
Frequency
Sleep regulation Wave 3


Mean = 4.49
Std. Dev. = .807
N = 2,880
Frequency
Reactivity Wave 1


Mean = 4.04
Std. Dev. = .94
N = 2,880
Frequency
Reactivity Wave 2


Mean = 4.43
Std. Dev. = .844
N = 2,880
Frequency
Reactivity Wave 3

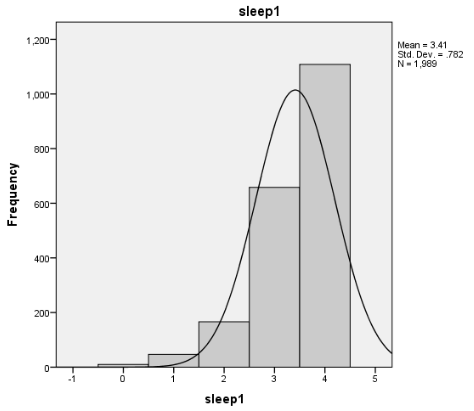

Mean = 4.34
Std. Dev. = .743
N = 2,880
Frequency
Persistence Wave 2

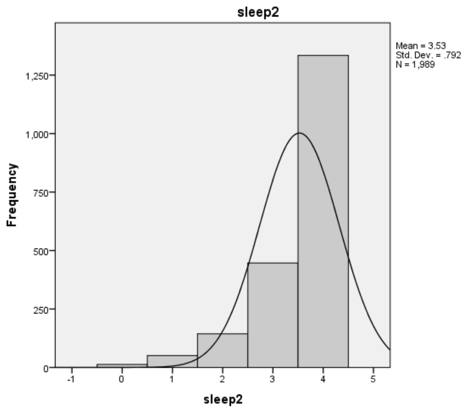

Mean = 3.89
Std. Dev. = .867
N = 2,880
Frequency
Persistence Wave 3

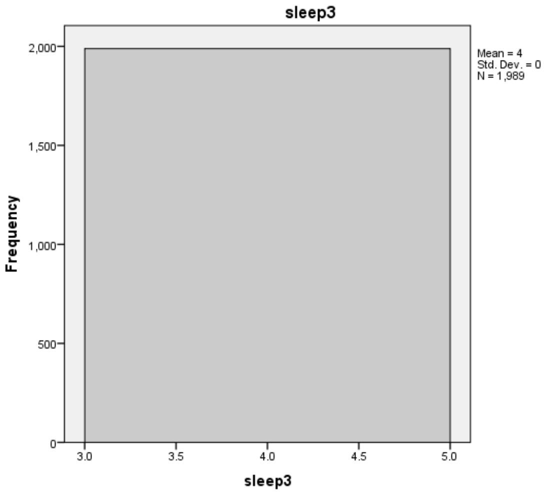
APPENDIX H DESCRIPTIVE STATISTICS AND HISTOGRAMS FOR THE SELF-REGULATION INDICATORS FOR EACH OF THE EARLY CHILDHOOD SELF-REGULATION PROFILES

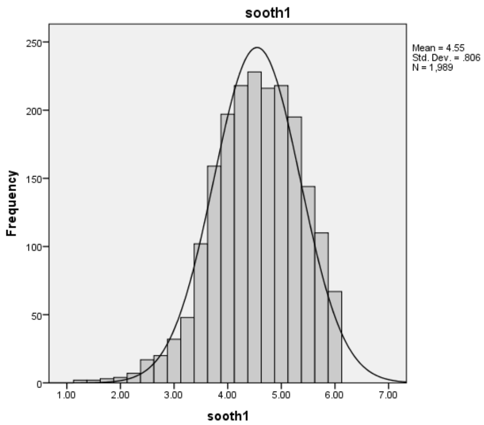
Profile 1 (Normative, *n* = 1989)

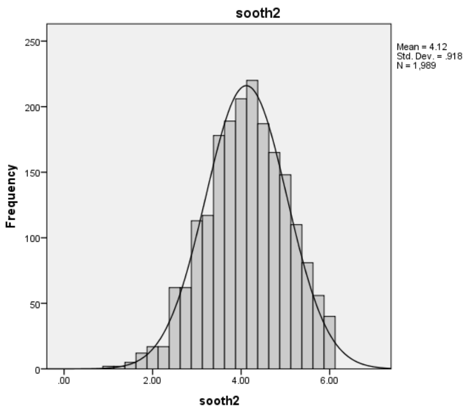
	M	*SD*	Skewness	Kurtosis
Birth to 1 year				
Sleep	3.41	.782	-1.413	2.060
Soothability	4.547	.806	-.436	.208
2 to 3 years				
Sleep	3.53	.792	-1.859	3.392
Soothability	4.12	.918	-.195	-.239
Persistence	4.372	.737	-.306	.302
4 to 5 years				
Sleep	4	0	na	na
Soothability	4.54	.799	-.581	.326
Persistence	3.97	.843	-.279	.138

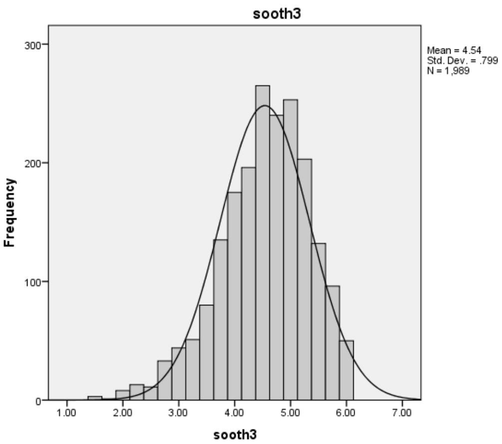


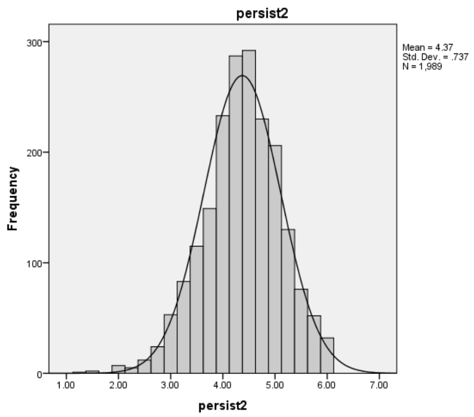


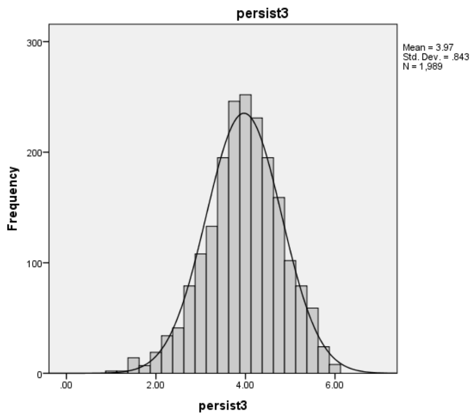

sleep3
Mean = 4
Std. Dev. = 0
N = 1,989
Frequency
sleep3


sooth1
Mean = 4.55
Std. Dev. = .806
N = 1,989
Frequency
sooth1


sooth2
Mean = 4.12
Std. Dev. = .918
N = 1,989
Frequency
sooth2

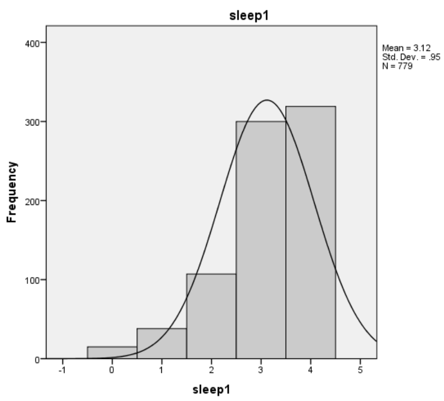

sooth3
Mean = 4.54
Std. Dev. = .799
N = 1,989
Frequency
sooth3

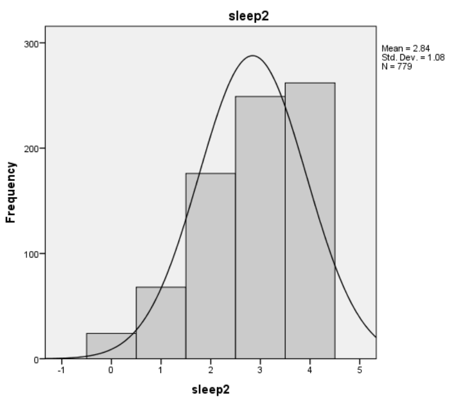


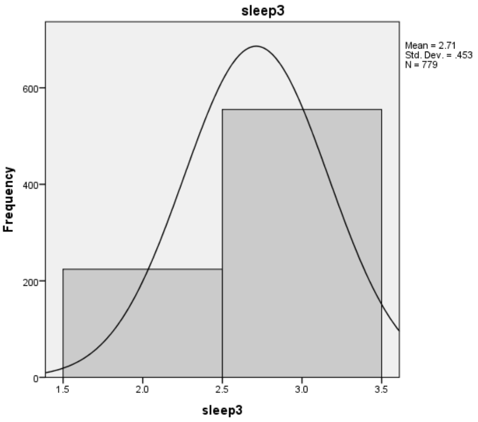


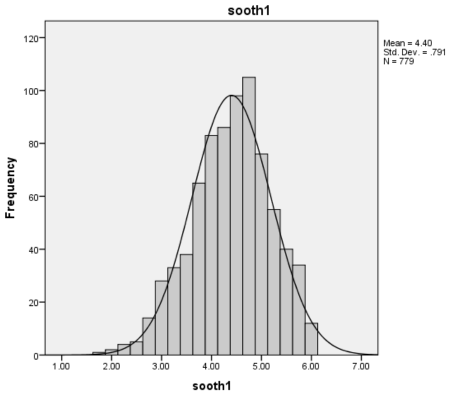
Profile 2 (Poor, *n* = 779)

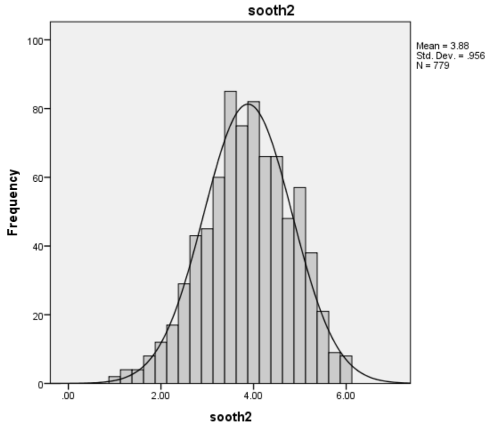
	M	*SD*	Skewness	Kurtosis
Birth to 1 year				
Sleep	3.12	.950	-1.118	1.024
Soothability	4.4	.791	-.312	-.157
2 to 3 years				
Sleep	2.84	1.080	-0.693	-.236
Soothability	3.88	.956	-.206	-.241
Persistence	4.28	.749	-.378	.534
4 to 5 years				
Sleep	2.71	.453	-.941	-1.118
Soothability	4.203	.878	-.506	.272
Persistence	3.723	.896	-.309	.085

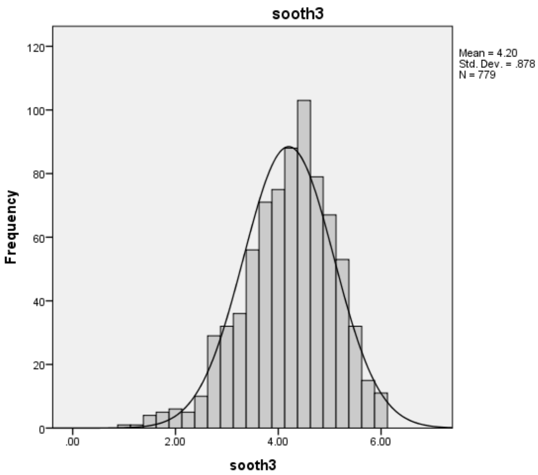


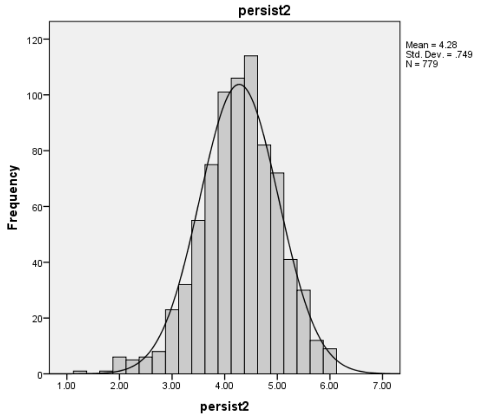


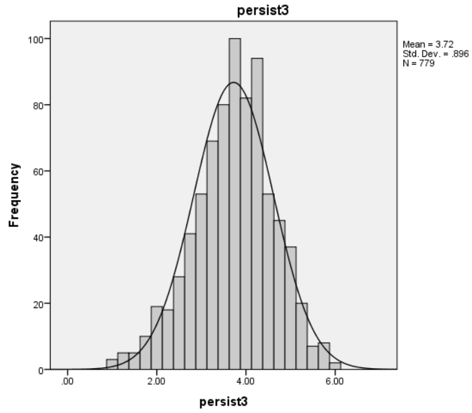

sleep3
Mean = 2.71
Std. Dev. = .453
N = 779
Frequency
sleep3


sooth1
Mean = 4.40
Std. Dev. = .791
N = 779
Frequency
sooth1


sooth2
Mean = 3.88
Std. Dev. = .956
N = 779
Frequency
sooth2

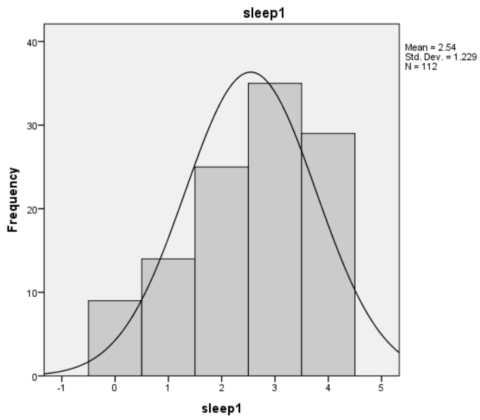

sooth3
Mean = 4.20
Std. Dev. = .878
N = 779
Frequency
sooth3

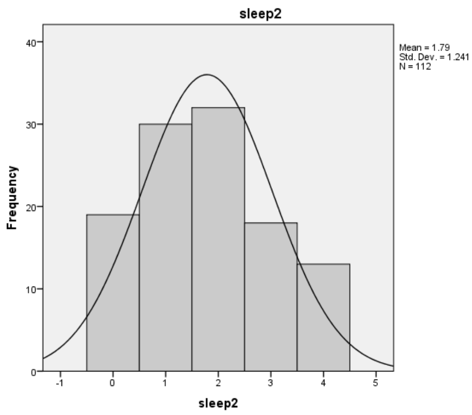


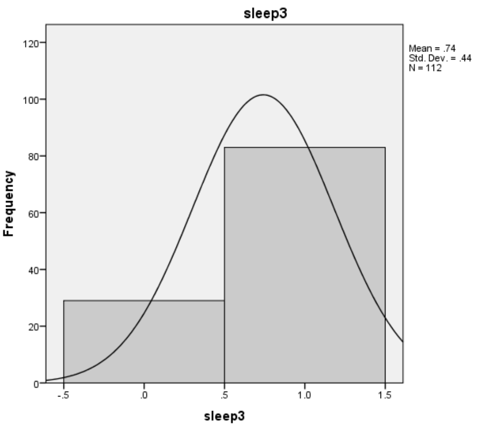


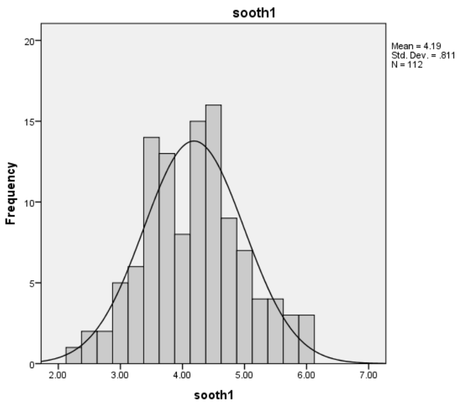
Profile 3 (Very poor, *n* = 112)

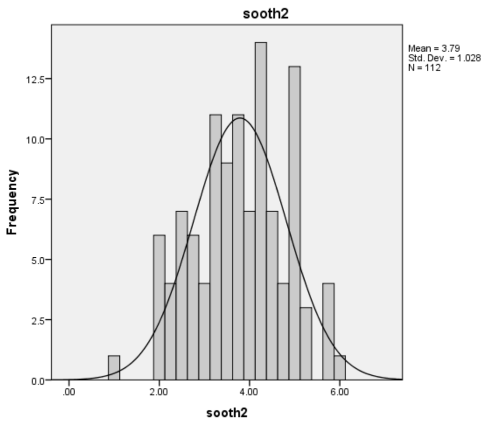
	M	*SD*	Skewness	Kurtosis
Birth to 1 year				
Sleep	2.54	1.229	-.549	-.623
Soothability	4.186	.812	.132	-.256
2 to 3 years				
Sleep	1.79	1.24	.245	-.850
Soothability	3.79	1.028	-.126	-.495
Persistence	4.27	.782	-1.046	2.453
4 to 5 years				
Sleep	.74	.440	-1.116	-.769
Soothability	3.79	1.028	-.126	-.495
Persistence	3.74	.895	-.239	.766

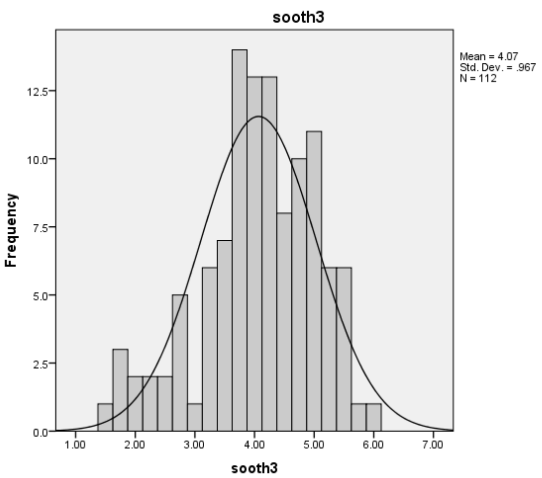


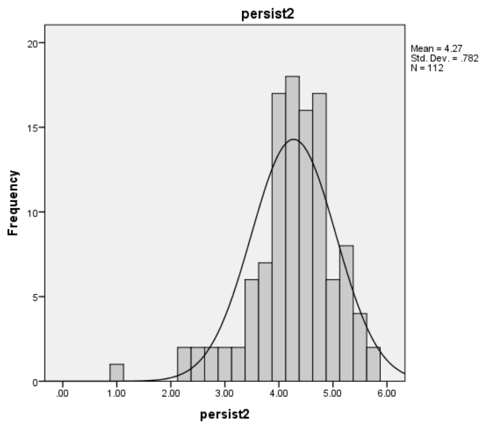


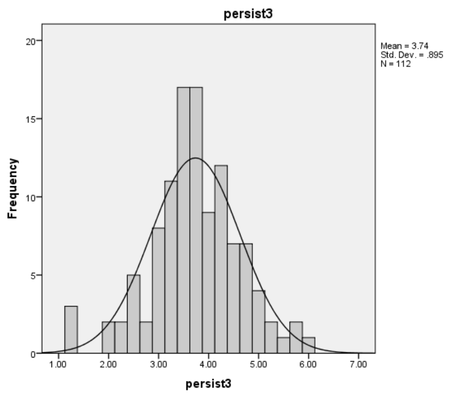

sleep3
Mean = .74
Std. Dev. = .44
N = 112
Frequency
sleep3


sooth1
Mean = 4.19
Std. Dev. = .811
N = 112
Frequency
sooth1


sooth2
Mean = 3.79
Std. Dev. = 1.028
N = 112
Frequency
sooth2


sooth3
Mean = 4.07
Std. Dev. = .967
N = 112
Frequency
sooth3


persist2
Mean = 4.27
Std. Dev. = .782
N = 112
Frequency
persist2


persist3
Mean = 3.74
Std. Dev. = .895
N = 112
Frequency
persist3

APPENDIX I RESEARCH OUTPUTS AND DISSEMINATION PLAN

<u>Outputs to date</u>

Refereed conference paper (related analyses):

Berthelsen, D., & **Williams, K.E.** (2013, July). *The relationship between children's emotional and cognitive self-regulation at 2 to 3 years and prosocial behavior in the early years of school*. Proceedings of 14th Annual Conference of the Pacific Early Childhood Education Research Association: Empowering Children's Empathy via Early Childhood Education. Seoul, Korea: Ewha Womans University and Educational Research Institute.

Conference papers:

Williams, K.E. & Berthelsen, D. (in submission). Predicting prosocial skills in the early school years: *The role of mothering, fathering, and children's self-regulation during toddlerhood.* Submitted as part of an oral symposium for the International Society for the Study of Behavioural Development Conference, Shanghai, China (July 2014).

Williams, K.E., Berthelsen, D., Walker, S., & Nicholson, J.M. (in submission). *Transactional relationships among children's emotional self-regulation and maternal mental health across early childhood.* Submitted as part of an oral symposium for the International Society for the Study of Behavioural Development Conference, Shanghai, China (July 2014).

Williams, K.E., Berthelsen, D., Nicholson, J.M., & Walker, S. (2013, November). *Self-regulation and maternal mental health interactions from birth to age seven: mother or child-driven effects?* Oral paper presented at the Growing Up in Australian and Footprints in Time LSAC and LSIC Research Conference, Melbourne, Australia.

Williams, K.E., Berthelsen, D., Walker, S., & Nicholson, J.M. (September, 2013). *A longitudinal analysis of relationships between children's early self-regulation, maternal mental health and children's behavior problems*. Poster paper presented at the 16th European Conference on Developmental Psychology, Lausanne, Switzerland.

Williams, K.E., Berthelsen, B., Walker, S., & Nicholson, J.M. (July, 2013). *A longitudinal analysis of relationships between early self-regulation, mothering, and children's behaviour problems.* Oral paper presented at the Australasian Human Development Association Conference, Surfers Paradise, Queensland, Australia.

Williams, K.E., Walker, S., Nicholson, J.M., & Berthelsen, B. (April, 2013). *Self-regulation from birth to age five: Associations among sleep, reactivity, and persistence, and outcomes at age seven.* Poster presented at the meeting of the Society for Research on Child Development, Seattle, Washington.

Media (related analyses):

Viellaris, R. (2013, August 24). Toddlers learn from tantrums. *Courier Mail,* p.4.

Dissemination plan

The candidate has been offered a six-month Early Career Researcher fellowship through the Excellence in Research in Early Years Education Collaborative Research Network (funded through the Australian Research Council). The plan for this fellowship includes the following items.

Proposed Paper: Predicting prosocial skills in the early school years: The role of mothering, fathering, and children's self-regulation during toddlerhood. (Submit to *International Journal of Behavioural Development*)

Proposed Paper: Relationships between early childhood self-regulation and motor development.

Proposed Paper: Relationships between early maternal reports of child self-regulation and school math learning. (submit to *Early Childhood Research Quarterly*)

Proposed Paper: The ways in which early childhood self-regulation contributes to developmental challenges apparent in early childhood education and care settings.